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The development and evaluation of an e learning module for neonatal clinicians to support breast feeding

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THE DEVELOPMENT AND EVALUATION OF AN E LEARNING MODULE FOR NEONATAL CLINICIANS TO SUPPORT BREAST FEEDING

By

WENDY HIGMAN

PhD

SEPTEMBER 2015



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*A thesis submitted in partial fulfilment of the University's
requirements for the Degree of Doctor of philosophy*

Abstract

The evidence that breastfeeding reduces mortality and short and long-term morbidity among premature and small babies is well established but breastfeeding rates in neonatal units in the UK remain low. The aim of this study was to develop and evaluate an eLearning module that addresses the learning needs of neonatal clinicians to support breastfeeding on Neonatal Intensive Care Units (NICU). The module focussed on the knowledge areas of anatomy and physiology of lactation and expression.

Mixed methodology was used to evaluate the eLearning module and inform its iterative development. This consisted of quasi-experimental pre-test/post-test studies using The Neonatal Unit Clinical Assessment Tool (NUCAT), an on-line objective knowledge test with self ratings of confidence to test the effects of the eLearning module on knowledge, confidence in knowledge and confidence in practice. Semi-structured interviews explored neonatal clinicians' experiences of undertaking the eLearning module and their perceptions of the feasibility and applicability of the eLearning module as well as their opinions and experiences of breastfeeding support and training.

In total 101 neonatal clinicians, including neonatal nurses, doctors, Advanced Neonatal Nurse Practitioners (ANNPs), nursery nurses and students undertook the initial NUCAT assessment of knowledge and confidence. A further 90 clinicians went on to complete the training and post intervention assessment, 60 repeated the post intervention assessment at 6-8 weeks.

Baseline knowledge was greater in the area of breast milk expression than in the anatomy and physiology of lactation. Neonatal nurses were found to have greater baseline knowledge of breast milk expression than doctors or nursery nurses. Doctors/ANNPs were more knowledgeable about the anatomy and physiology of lactation. Following the training intervention doctors/ANNPs showed the greatest improvement in knowledge scores and nursery nurses the least. Knowledge and confidence was significantly increased immediately following the intervention and at 6-8 weeks in all groups. The semi-structured interviews

conducted after the study showed the feasibility and applicability of the eLearning module for clinicians in NICU.

On-line assessment and training provide a potentially effective multidisciplinary training method to improve breastfeeding knowledge and confidence. Nursery nurse may have differing learning needs and require further support and training.

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Table of Contents

Chapter 1 - Introduction	18
1.1 Breastfeeding Policy	18
1.2 Difficulties with breastfeeding in NICU	20
1.3 Breastfeeding education for clinicians.....	20
1.4 The development and evaluation of an eLearning intervention for clinicians’ to support breastfeeding practices in NICU.....	22
1.5 Thesis aims.....	26
1.6 Chapter Summary: The structure of the thesis.....	27
Chapter 2 - Literature Review	29
2.1 Section 1 - The Benefits of Breastfeeding.....	29
Introduction.....	29
2.1.2 Health Benefits of Breastfeeding the Full Term Infant	29
2.1.3 Health Benefits of Breastfeeding Preterm or Low Birth Weight Infants	36
2.1.4 Economic Benefits of Breastfeeding	41
2.1.5 Alternatives to Breastfeeding	42
2.1.6 Conclusion.....	43
Section 2 - Background Literature to Support and Inform the Development of the eLearning module	45
2.2.1 Background	45
2.2.2 Lactogenesis.....	45
2.2.3 Factors that support breast milk expression in a NICU context.....	48
2.2.4 Factors that inhibit breast milk expression in NICU context.....	52
2.2.5 Potential Adverse effects Associated with Breast Milk Pumping	57
2.2.6 Conclusion.....	59
Section 3 - Review of Educational interventions for clinicians to improve breastfeeding outcomes in NICU	61
2.3.1 Introduction	61

2.3.2 Methods of review	64
2.3.3 Results	66
2.3.4 Summary of Findings	76
2.3.5 Discussion	80
2.3.6 Conclusion.....	86
2.3.7 Chapter Summary	89
Chapter 3 - eLearning Design and Pedagogy	90
3.1 Introduction	90
3.2 eLearning	90
3.3 eLearning design	92
Ensure equity of access and quality of provision	93
Innovative and evidence-based with high quality of educational outcomes.....	93
Value for money.....	94
Educationally coherent.....	94
Patient-centred and service driven.....	94
Improves patient outcomes safety and experience	94
3.4 Needs Analysis	95
3.5 Setting learning objectives	97
3.6 Technology and resources.....	98
3.7 Approaches to learning	99
3.8 Continued professional development (CPD).....	102
3.9 Active learning	103
Justification for module.....	103
Cognitive Load Theory (CLT).....	104
3.10 Assessment	105
3.11 Chapter summary.....	105
Chapter 4 Methodology	107
4.1 Introduction	107

4.2 Educational research.....	107
4.3 Epistemological paradigm	110
4.4 Methodology for the current research project.....	112
Mixed methods.....	112
4.5 Quantitative methodology	115
Aims.....	115
Quantitative study design	116
Statistical Analysis	118
4.6 The eLearning intervention	121
4.7 Measures	121
Knowledge.....	121
Confidence/Self-Efficacy	122
NUCAT	123
4.8 Procedure	126
Research site	126
Participants.....	126
4.9 Qualitative methodology.....	128
4.9.1 Evaluation	130
4.9.2 Clinician interviews	131
4.10 Ethics.....	136
Ethical issues in testing.....	136
Ethical issues in interview	137
4.11 Chapter summary.....	138
Chapter 5 - Development and Evaluation of the eLearning Module	139
5.1 Introduction	139
5.2 Stage 1 - Identify and analyse problems by researcher and practitioners in collaboration	139
5.2.1 Stage 2 – Study One.....	144
First iteration in the development of prototype solution –.....	144

eLearning Module (Version One)	144
Learning aims and objectives	144
Structure	147
Design considerations	147
Pedagogic considerations	148
Development of content aligned to learning aims	151
5.2.2 Stage 3 - Testing and refinement	156
Evaluation of Study One	156
5.2.3 Stage 4 - Practical Redesign Steps Taken	175
5.3.1 Stage 2 – Study Two	179
Second iteration in the development of prototype solution –	179
eLearning Module (Version 2)	179
Learning aims and objectives	179
Structure	180
Design considerations	181
Pedagogic considerations	182
Development of content aligned to learning aims	185
5.3.2 Stage 3 - Testing and refinement	189
Evaluation of Study Two	189
Aims	189
5.3.3 Stage 4 - Practical redesign steps taken	201
5.4 Chapter Summary	202
 Chapter 6 – Evaluation Version Three of the eLearning Module: Knowledge and Confidence Outcomes	 203
6.1 Introduction	203
6.2 Aims	204
6.3 Analysis Aims 1 - 5	205
6.3.1 Characteristics of baseline study participants	206
6.4 Results Aim 1	207

Baseline knowledge	207
6.5 Results Aim 2	210
Baseline Confidence	210
6.6 Results Aim 3	213
Knowledge.....	213
6.7 Results Aim 4	216
Confidence.....	216
6.8 Results Aim 5	219
Mean total knowledge scores over time	219
Mean anatomy and physiology of lactation knowledge scores over time.....	219
Mean breast milk expression knowledge scores over time	220
Mean total confidence scores over time	220
Mean confidence in knowledge scores over time	221
Mean confidence in practice scores over time.....	221
6.9 Discussion	223
Findings relating to clinicians' baseline total knowledge and total confidence	223
Findings relating to clinicians' post intervention total knowledge and total confidence.	225
6.11 Chapter summary.....	227
 Chapter 7 - Evaluation of Version Three of the eLearning Module: Analysis of User	
Feedback	228
7.1 Introduction	228
7.2 Aims.....	228
7.3 Results Aim 1	228
7.3.1 NUCAT item analysis.....	228
7.3.2 NUCAT question feedback	231
7.3 Results Aim 2	234
Open Questions at the end of the Assessment	236
7.4 Results Aim 3	241
Characteristics of respondents.....	242

Analysis	243
Theme 1: Experience of undertaking the eLearning module	245
Anatomy and physiology content.....	245
'Relevance to multidisciplinary team'.....	246
'Design of the eLearning module'	248
'Ease of use'.....	250
'eLearning disadvantages'	251
'Suggestions for Improvement'	251
Theme 2: Experience of undertaking NUCAT assessment	252
'Questions were mostly relevant and appropriate'.....	252
'Helped to recognise gaps in knowledge'	253
Theme 3: Previous experience of breastfeeding support	255
'Need for clinical experience to build confidence'	255
'Understood the benefits of breastfeeding'	257
'Mothers require time'	258
'Walking a fine line to respect the mothers' wishes'	260
'Communication and rapport with the mother'	261
'Recognised difficulties for mothers'	262
'The need for consistent advice'	264
Theme 4: Experience of previous breastfeeding training	266
'Useful but not always relevant to NICU'	266
'Lack of anatomy and physiology content'	267
'Variety of training needs'	268
7.5 Discussion	269
7.6 Chapter summary	272
Chapter 8 – General Discussion	273
8.1 Introduction	273
8.2 Summary of Results	273
8.2.1 Research Question One.....	273

8.2.2 Research Question Two.....	275
8.3 Reflection on the use of the Reeves (2006) model of educational research design	277
8.4 Critical evaluation of the contribution of results	284
8.4.1 Study Strengths.....	284
8.4.2 Study limitations	286
8.5 Recommendations for Future Studies.....	294
8.6 Conclusion	296
References.....	300
Table of Appendix.....	325

List of Tables

Table 1. Included Studies: Design, Participants, Setting, Method and Interventions.....	69
Table 2. Included Studies: Outcomes, Measurement, Results, Inclusion/Exclusion and Limitations.....	71
Table 3. Recommendations for Improving the Reporting and Synthesizing of Educational Interventions for educational Researchers (Reed 2005).....	108
Table 4. Clinicians' ratings of their confidence in knowledge and confidence in practice to support breastfeeding	142
Table 5 Description of learning content of breastfeeding training courses and the eLearning module.....	145
Table 6. Study One aims and learning objectives matched with eLearning content.....	146
Table 7. Study Two defining Approaches to Learning	150
Table 8. Showing Storage of Breast Milk in Hospital or Home (UHCW NHS Trust Local Policy Guidelines)	153
Table 9. Factors that may contribute to the inhibition or delay in milk production	155
Table 10. Results from Study One t-Tests.....	158
Table 11. Study One pre and post intervention question responses.....	160
Table 12. Study one NUCAT question item with eLearning extract.....	162
Table 13. Study One question items identified for replacement in study two	166
Table 14. Study One Free text responses to individual NUCAT item questions.....	168
Table 15 Study One Interview Themes	171
Table 16. Study Two aims and learning objectives matched with eLearning content.....	179
Table 17. Study Two defining approaches to learning.....	184
Table 18. Assessment for readiness to learn	188
Table 19. Results from Study Two t-Tests	191
Table 20. Study Two pre and post intervention scores.....	193
Table 21. Study two NUCAT question item with eLearning extract.....	194
Table 22. Study two free text responses to individual NUCAT item questions	198

Table 23. Study Two user feedback.....	200
Table 24. Baseline Characteristics of Study Participants.....	206
Table 25. Baseline (T0) Knowledge Scores and Descriptive variables (n=101)	209
Table 26. Baseline (T0) Confidence Scores and Descriptive variables (n=101)	212
Table 27. Differences in mean total knowledge scores between pre and immediate post eLearning intervention in sub-groups	215
Table 28. Differences in mean total confidence scores between pre and immediate post eLearning intervention in sub-groups	218
Table 29. Changes in Scores Over Time.....	222
Table 30. Study Three pre and post intervention scores	230
Table 31. Study Three free text responses to individual NUCAT item questions.....	232
Table 32. Comments on the Theme of Anatomy and Physiology.....	237
Table 33. Comments on the Theme of Use of Video	238
Table 34. Comments on the Theme of Relevance and Ease of Use.....	239
Table 35. Comments on the Theme of Confidence	239
Table 36. Comments on the Theme of Most Useful Information	240
Table 37. Comments on the Theme of Areas for Improvement	241
Table 38. Characteristics of participants (n=10).....	243
Table 39. Main themes emerging from the interviews.....	244
Table 40. Table of key design principles	275
Table 41. Key study findings.....	277

List of Figures

Figure 1. Stages of educational design research.....	24
Figure 2. Flow chart differentiating this thesis from earlier work by Wallace et al. (2013)	
Figure 3. Search strategy flow diagram	67
Figure 4. Six Key Principles to Support eLearning in the Health and Social Care Workforce [adapted from A Framework for Technology Enhanced Learning, DH (2011)	93
Figure 5.The Johari Window	96
Figure 6. Study Flow Design	114
Figure 7. Study Three Design Flow Chart.....	117
Figure 8. Reeves (2006) stages of educational design research.....	139
Figure 9. The proportion of clinicians who scored in each quartile for the total score and for each of the six knowledge areas on NUCAT from study by Wallace et al. (2013).	141
expressing milk for babies on the Neonatal Unit.....	154
Figure 10. Results Study One. Percentage of participants with correct scores for anatomy and physiology, breast milk expression and total knowledge	157
Figure 11. Study One pie charts illustrating the participant responses to the survey questions	170
Figure 12.Translation of evaluation results into design action points.....	178
Figure 13. Study Two percentage of participants with correct scores for anatomy and physiology, breast milk expression and total knowledge	190
Figure 14. Pie charts to show comparisons in feedback from participants in Study 1 and Study 2.....	199
Figure 15. Study Flow Design indicating participant numbers.....	204
intervention in sub-groups.....	215
Figure 16. Study Three pie charts to show comparisons in feedback for ease of use from participants in Study 1, 2 and 3	235
Figure 17. Study Three pie charts to show comparisons in feedback duration of learning from participants in Study 1, 2 and 3	235

Figure 18. Study Three pie charts to show comparisons in use of feedback of scores from participants in Study 1, 2 and 3	236
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List of Images

Image 1. Screenshot of webpage showing video describing the anatomy and physiology of milk production.....	151
Image 2. Screenshot of webpage showing video of nurse teaching a mother to hand express	153
Image 3. Screenshot of webpage showing video that highlights common problems for mothers	154
Image 4. Screenshot of webpage showing layout of training module_.....	181
Image 5. Screenshot of webpage showing video describing the anatomy and physiology of milk production.....	185
Image 6. Screenshot of webpage showing the breast pump expression video.....	186

Chapter 1 - Introduction

1.1 Breastfeeding Policy

Infant nutrition plays a key role in reducing morbidity and mortality of infants and, in particular, breast milk has been associated with a reduction in a number of morbidities (Chen and Rogan 2004). This has been recognised in several evidence-based policy initiatives that have been put in place globally over the past 10 years, which have promoted the initiation, duration and exclusivity of breastfeeding. The American Academy of Paediatrics (AAP), The U.S. Surgeon General, The United Nations Children's Fund (UNICEF), and The World Health Organisation (WHO) promote breastfeeding and/or the use of human milk as the ideal form of infant nutrition for the first year of life (Gartner et al. 2005). The American Dietetic Association (ADA) recommend exclusive breastfeeding for the first six months of life, and then continued breastfeeding, in addition to complementary foods, for at least the first 12 months of life and beyond (Delores et al. 2009). Current UK policy is to promote exclusive breastfeeding for the first 6 months of life. Thereafter, it recommends that breastfeeding should continue for as long as the mother and baby wish, while gradually introducing a more varied diet (DH 2003).

Whilst a considerable body of evidence supports the benefits of breastfeeding healthy term infants, these are even greater for sick or preterm babies in neonatal intensive care (NICU). Furthermore, the promotion of breastfeeding for low birth rate infants has been found to be highly cost effective, primarily because of a reduced incidence of necrotizing enterocolitis (NEC) (Lowson et al. 2015; Rice et al. 2010). However, the NICU environment presents an enormous challenge for mothers to provide breast milk for their infants. When babies are admitted to NICU, due to prematurity or illness, they are often unable to take milk directly from their mother (Renfrew et al. 2009a). As a result, mothers experience separation and are often unable to undertake the traditional role of caregiving, as the onus of care shifts to health care professionals. Consequently, a mother who may have hoped to breastfeed her

child, may find that she is unable to do so and instead must be supported in providing breast milk for her infant through expressing by hand or pump.

In 1991, The World Health Organization (WHO) and UNICEF launched The Baby-Friendly Hospital Initiative (BFHI) Ten Steps to Successful Breastfeeding as a global effort to implement practices that protect, promote and support breastfeeding (Appendix 1). In the UK, both NICE (National Institute for Health and Care Excellence) and The Royal College of Paediatrics and Child Health (RCPCH) recommend that the UNICEF UK Baby Friendly Initiative (BFHI) should be the minimum standard for the NHS, suggesting a combination of interventions including antenatal education, peer support, and education and training for health professionals (NICE 2014). In order for NHS Trusts and other health care facilities to become accredited with BFI status (The BFI is an adaptation of the BFHI that reflects a continuum of care from hospital to community), they must demonstrate implementation of best practice in the provision of breastfeeding support. There are four stages to full BFI accreditation and currently, in the UK, 45% of babies are delivered in fully accredited hospitals (UNICEF, 2015).

In 2009, the need was identified to develop further BFHI guidelines to provide additional information on supporting breastfeeding in NICU (WHO 2009). The resultant Expanded Ten Steps and Three Further Guiding Principles were developed in 2012 (Nyqvist et al. 2013) to adapt to the special situation of preterm infants (born at a gestational age of less than 37 weeks), sick infants, and their mothers. This study will focus on the second of the ten steps that aims to educate and train all staff in the specific knowledge and skills necessary to implement this policy. This aim further supports the first new guiding principle that staff attitudes to mothers must focus on the individual and her situation. The most recent policy statement from the Section on Breastfeeding of the AAP represents a significant shift from previous statements. Its recommendation is that all preterm infants should receive human milk, with pasteurised donor milk rather than premature infant formula being the preferred alternative if a mother is unable to provide an adequate volume herself (Underwood 2013).

1.2 Difficulties with breastfeeding in NICU

The number of mothers of very low birth weight (VLBW) infants who initiate breastfeeding is substantially lower than mothers of term infants (Neville et al. 2001) and preterm birth has also been linked to shorter breastfeeding duration (Flacking et al. 2007; Pineda 2011b). An Italian, multicentre study (Davanzo et al. 2012) recorded data from 2948 infants with a median gestation of 35 weeks and reported that 28% of infants were discharged home exclusively breastfeeding, with fewer low birth weight (LBW) infants receiving exclusive human milk than those in higher birth weight categories. In 2003, Bonet et al. (2011) compared discharge breastfeeding rates for very preterm infants (22–31 weeks of gestation) in European regions, and found rates varied from 19% in Burgundy to 70% in Lazio. This wide range reflects the difficulties that mothers of experience maintaining a supply of milk for preterm and sick babies from birth to discharge home. However, this study also found that breastfeeding rates for very preterm babies correlated with overall national breastfeeding rates, suggesting that a breastfeeding-friendly environment, reflected by a high national rate, favours this practice on NICUs.

In England and Wales in 2011, 7.2% of births were preterm (< 37 weeks gestation), (Office for National Statistics, 2014). In 2012, the National Neonatal Audit Programme (NNAP) reported that 59% of babies born at less than 33 weeks gestation were receiving mother's milk, exclusively or with another form of feed, at the time of their discharge from neonatal care (NNAP 2013). Exclusive breastfeeding at discharge from NICU poses even greater challenges to mothers, however a Danish study of 1,488 preterm infants reported that 68% of the preterm babies left NICU exclusively breastfeeding (Maastrup et al. 2014b). Studies such as these provide important information on approaches to support successful breastfeeding and highlight what can be achieved in the challenging environment on NICU.

1.3 Breastfeeding education for clinicians

Because the NICU environment presents significant barriers to breastfeeding, mothers require support and advice on how to provide breast milk for their children. The BFI states that all

those in contact with breastfeeding mothers should receive education and have clinical experience in breastfeeding management (WHO/UNICEF1998). In order for health professionals to be able to support mothers who wish to breastfeed on NICU, they need to be equipped with the appropriate skills to educate, promote and protect breastfeeding. To achieve this, the multidisciplinary team must work collaboratively to provide consistent advice to mothers. Health professionals play a major role in determining the feeding outcomes in these fragile and vulnerable infants, and it is essential that they receive up to date, evidence based education and training (Dykes 2006; Renfrew et al. 2009b; Ward and Byrne, 2011; Nyqvist et al. 2013) and that this includes education in how to support mothers' with breast milk expression (Entwistle 2013). Furthermore, for nurses, this knowledge requires updating in order to ensure they practice safely and effectively within their scope of practise (Nursing and Midwifery Council 2015).

Currently in the UK, training in breastfeeding management is made available to the multidisciplinary team, and is a mandatory requirement for all hospital staff working within NICU UNICEF BFI. However, some studies have shown that hospital-based nurses lack confidence and knowledge in supporting mothers to breastfeed (Bernaix 2000a; Cricco-Lizza 2009b; Weddig et al. 2011b; Brewer 2012). The impact of a lack in staff breastfeeding knowledge can result in poor breastfeeding advice. This has been identified in two meta-syntheses of women's experiences of breastfeeding support, showing that the effects of contradictory or outdated information on mothers are both ineffective and counterproductive (Larsen et al. 2008; Schmied et al. 2011). A systematic review of factors that help or hinder breast milk supply in NICU found that parents had reported the provision of inconsistent information and a lack of expert advice in breastfeeding support in five out of seven studies (Alves et al. 2013). Quality improvement interventions to promote breastfeeding in NICU that include education and training of staff, have been shown to be effective but have not provided a robust assessment of staff knowledge (Lee et al. 2012; Ward et al. 2012; Gianni et al. 2014; Dereddy et al. 2014).

There is a paucity of studies that evaluate the efficacy of breastfeeding training interventions on health professionals (Watkins and Dodgson 2010) and a lack of evidence to direct the development of breastfeeding education (McFadden et al. 2006). Studies that have evaluated education and training interventions have shown that they can improve breastfeeding rates and/or knowledge in both primary care and hospital settings (Hillenbrand and Larsen 2002; O'Connor et al. 2011; Ingram et al. 2011; Ward and Byrne 2011; Blixt et al. 2014). The various ways in which training interventions are delivered include face-to-face teaching, lectures and guided self-study. Studies that have evaluated online breastfeeding education programmes aimed at improving breastfeeding knowledge have also shown to be effective (O'Connor et al. 2011; Weddig et al. 2011a; Lewin and O'Connor 2012; Deloian et al. 2015). However, in the NICU environment only a small number of studies have measured the impact of training interventions on health care professionals knowledge of breastfeeding skills (Siddell et al. 2003; Jones et al. 2004; Pineda et al. 2009; Bernaix et al. 2008), and no study has been undertaken that has assessed clinician confidence and knowledge in skills to support breastfeeding practices in NICU, following an eLearning intervention.

1.4 The development and evaluation of an eLearning intervention for clinicians' to support breastfeeding practices in NICU

eLearning is increasingly used in continued professional development (CPD) (Harden 2005) and is recognised by both the Royal College of Nursing and The Royal College of Paediatrics and Child Health as a valid method in supporting health professionals training. This study aimed to develop and evaluate an eLearning intervention for clinicians to support breastfeeding practices in NICU, and the educational content is aimed at the multidisciplinary team. Inter professional education (IPE) is defined as an intervention where the members of more than one health or social care profession learn interactively together, for the explicit purpose of improving inter professional collaboration (Reeves et al. 2015). In their critical discussion of educational requirements of health practitioners, Dykes (2006) highlights the need for an inter agency and interdisciplinary collaborative model of breastfeeding education

for health professionals, identifying this as crucial in developing a coherent and cohesive approach to delivering breastfeeding support. Whilst medical staff do not need to know how to provide “hands-on” breastfeeding support, their role requires them to deliver support and advice that promotes breastfeeding (Holmes et al 2012) and this should be in line with information provided by the NICU team as a whole. Previous studies have reported improvements in knowledge when including the multidisciplinary team in breastfeeding training programmes (Ingram 2006; Jones et al. 2004; Pineda et al. 2009). However, none of these studies have used eLearning to deliver training, this study therefore, offers a unique opportunity to assess the impact on knowledge and confidence of breastfeeding CPD training for the multidisciplinary team using an eLearning format.

There is a paucity of literature that describes educational theory when evaluating educational interventions. In their systematic review of nine studies on education and evidence-based practice interventions with health professionals and breastfeeding counselors on duration of breastfeeding, Spiiby et al. (2009) report a lack of educational theory describing the educational programmes. Further to this, a recent literature review of eLearning in nurse education described an urgent need to develop robust instruments to measure the impact, effectiveness and perceptions of students and educators who are using eLearning (Button et al. 2014). This study addresses these two issues because it aims to develop a theory led intervention and robust assessment of knowledge.

In order to design an effective intervention for a given learning objective, there is a need for theory-guided and theory-building studies with robust evaluations that provide practical guidance for subsequent implementations (Cook 2012). Such studies should report on both the benefits of an instructional or assessment intervention, as well as any problems or difficulties, in order to recognise the strengths and weaknesses of each. Cook et al. (2008) identify these types of studies as clarification studies, describing them as key to advancing our understanding of medical education because rather than focusing on existing interventions, like description or justification studies, they provide insights that can inform

Development of
prototype solutions:
informed by state of
art, existing design
principles &
technology
innovations



was the site for an earlier study that informed the development of this PhD. In 2012, (Wallace et al. 2013) used an innovative instrument, The Neonatal Unit Clinical Assessment Tool (NUCAT), to assess the knowledge and self assessed confidence of neonatal clinicians in NICU and identify future learning needs. An analysis of learning needs has been identified as a first step in a cyclical process of an overall strategy for training and education, as this can help to inform educational programmes (McFadden et al. 2006). The results of the NUCAT study provided the basis for the content design for the eLearning intervention used in this PhD (Figure 2).

Figure 2. Flow chart differentiating this thesis from earlier work by Wallace et al. (2013)

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Through combining the online assessment with the eLearning intervention, an e portal was developed that is a unique and comprehensive approach to both assessing training needs, providing educational material and subsequently evaluating knowledge and practice skills. Because this study aims to understand the processes and outcomes when using an eLearning intervention, it is appropriate to combine quantitative and qualitative methods to undertake a mixed methods evaluation. Mixed method design is well suited to educational research because it has the potential to capture the strengths and counterbalance the weaknesses of both approaches, which can be seen as particularly powerful when addressing multifaceted and complex issues such as the design of eLearning interventions (Lavelle et al. 2013).

1.5 Thesis aims

To date, there are no studies that have investigated the impact of eLearning on health care professionals' knowledge and confidence to support mothers to breastfeed in the NICU. The unique contribution of this study is therefore in its aim to develop eLearning for neonatal clinicians to enhance their knowledge and confidence in supporting mothers with breastfeeding. The design and development of an innovative eLearning module is undertaken using an iterative approach in order to ensure it is fit for purpose. The effectiveness of the eLearning module is evaluated by the assessment of knowledge and confidence of NICU clinicians' pre and post intervention.

This thesis aimed to answer the following research questions:

1. What makes an effective eLearning module for clinicians to support breastfeeding in NICU?
2. Is eLearning an effective way to improve the knowledge and confidence of clinicians to support breastfeeding practices in NICU in two areas of knowledge:
 - a. The anatomy and physiology of lactation
 - b. Breast milk expression

To answer these research questions, this thesis reports:

- The methods and processes used to develop an e-Learning module to meet the essential knowledge and practice skills required of inter-professional clinicians (nurses, nursery nurses and junior doctors) to support breastfeeding on NICU.
- A mixed methods evaluation of the eLearning module consisting of:
 - Quasi-experimental pre-test/post-test studies: to test the effects of the eLearning module on knowledge, confidence in knowledge and confidence in practice.
 - An exploration of neonatal clinicians' experiences of undertaking the eLearning module and their opinions and experiences of breastfeeding support and training using qualitative methodology.

1.6 Chapter Summary: The structure of the thesis

The remainder of this thesis comprises 7 chapters:

Chapter 2 presents the scientific evidence base for supporting breastfeeding in infants and in particular preterm and sick infants, and a literature review of the evidence to support the practice of breast milk expression on NICU. This will include current literature that describes the potential benefits of breastfeeding, in both the general infant population and also the preterm and sick infant population, locating the importance of breastfeeding in terms of a world health issue. Because this thesis aims to provide education for practitioners in supporting breastfeeding in NICU, the current evidence base supporting breast milk expression practices that was used to inform the development of the content for the eLearning module is also described. Finally, this chapter will provide a literature review of studies that have evaluated breastfeeding training interventions in NICU by focussing on clinician knowledge to support breastfeeding in NICU.

Chapter 3 outlines the conceptual frameworks that were used to inform the design of the eLearning module including a discussion of the pedagogic principles employed.

Chapter 4 discusses the methodological approach adopted in this study. Justification for the adoption of a combined rather than single methodology used in this study will also be presented.

Chapter 5 provides a description of Study One and Study Two that detail the development and evaluation of the eLearning module through its first two iterative phases (Version One and Two). The findings from the evaluations of these studies inform the development of the final iteration of the eLearning module (Version 3).

Chapter 6 presents the quasi-experimental pre-test/post-test studies that tested the effects of Version Three of the eLearning module on knowledge, confidence in knowledge and confidence in practice.

Chapter 7 presents an exploration of neonatal clinicians' experiences of undertaking Version Three of the eLearning module and their opinions and experiences of breastfeeding support and training using qualitative methodology. Evaluation questions, open text feedback from the NUCAT assessment and semi-structured interviews were used to obtain this information.

Chapter 8 evaluates the extent to which the aims of the research have been fulfilled together with a summary of the main findings and their implications. This chapter will also suggest directions for future research.

Chapter 2 - Literature Review

2.1 Section 1 - The Benefits of Breastfeeding

Introduction

It is widely recognised that breastfeeding is good for the health of an infant and its subsequent development, and that preterm and sick newborn babies particularly benefit from breast milk (WHO 2009; NICE 2014; Renfrew et al 2009a). In the UK, approximately 90,000 babies are admitted to NICU and of these around 18,000 need the highest intensive care (Redshaw and Hamilton 2006). Providing breast milk in NICU is subject to more difficulty as the infant is unable to feed at the breast and mothers are often unable to hold and care for their babies in a stressful environment. This chapter will describe the literature that explores the benefits of breastfeeding in both the term and preterm infant and the methods that are employed in NICU to support a mother with breastfeeding. The final section will review current literature evaluating breastfeeding training interventions in NICU that have particularly focused on knowledge outcomes, in order to explore their effectiveness in training clinicians.

To provide the best reliable evidence, this literature review was limited to include meta-analyses, systematic reviews and well-designed studies to describe the association between breastfeeding and health. Whilst randomised controlled trials are recognised as the 'gold standard' of research studies they are very rare in this field due to the ethical implications of randomly allocating mothers to breastfeed.

2.1.2 Health Benefits of Breastfeeding the Full Term Infant

Decreased risk of gastrointestinal diseases

The first 1,000 days of fetal/infant life is deemed as a crucial period in infant metabolic and cognitive development and can be divided into three phases: pregnancy, breast (or formula)

feeding, and a period of increasing complementary feeding (Neville et al. 2012). Human milk is uniquely tailored to meet the nutritional needs of human infants and has the appropriate balance of nutrients provided in easily digestible and bioavailable forms (Delores et al. 2009). Colostrum is the first milk secreted by lactating women, in small volumes, within the first 2 days after birth. It plays an important role in the newborn's transition to extra uterine life, as it provides a thick, sticky fluid that coats the lining of the gut and helps to protect it from early pathogens (Arnold 2010 pg. 88). Because colostrum contains very little IgG, the main type of antibody to fight infection, it does not directly provide systemic immunity. However, it does contain growth factors, cytokines and erythropoietin that can suppress inflammatory responses in the immature neonatal intestine (Neville et al. 2012). Breast milk provides short-term protective effects against infection through epidermal growth factor, which helps to induce maturation of the intestinal epithelium, and high concentrations of protective components such as secretory immunoglobulin A (sIgA) (Hanson, 2006). Breast milk also contains lactoferrin and oligosaccharides, which provide protection to mucosal surfaces through prevention of attachment of pathogens and which broad antimicrobial properties include the disruption of the bacterial outer membrane (Lawrence and Pane 2007).

The immaturity of the newborn's gut and immune system puts the infant at increased risk for gastrointestinal illness (Bernt and Walker 1999), and respiratory and gastrointestinal tract infections are the leading cause of morbidity in children (Bryce et al. 2005). In a mature gastrointestinal tract the intestinal epithelium acts as a barrier to bacteria or toxins. Gastric acidity, pancreatic enzymes, and gut peristalsis prevent pathogens from attaching to the gut wall and causing gastrointestinal illness (Montenegro & Martin 2014). In neonates, gastric secretion and pancreatic enzyme production is less than in an older baby, and at birth the epithelium of the infant's intestine is more permeable to bacteria. Breastfeeding can have an effect on infant health by influencing the composition of the indigenous intestinal microbiota because breast milk contains substances that promote the growth of bifidobacteria. This helps to promote intestinal barrier function, inhibit pathogen adherence and colonization and enhance antigen specific IgA production (Rautava 2007).

Breast milk contains many active constituents that are able to transmit biochemical messages, including hormones, enzymes, cytokines, lactoferrin, and other milk-specific substances. Many of these have maturational effects on the intestinal mucosa, thereby decreasing the risk of gastrointestinal illness (Bernt and Walker 1999). Importantly, human milk contains complex bacterial communities that are often highly personalized to the lactating woman (Hunt et al. 2011). These bacteria can be regarded as natural probiotics to inoculate the infant's intestinal microbiota through the entero-mammary pathway. In the UK, it was estimated that 53% of hospitalizations of infants for diarrhoea in the first 8 months of age could have been prevented each month if all infants were exclusively breastfed, and 31% could have been prevented if all were partially breastfed (Quigley et al. 2007). In one meta analysis of approximately 400 individual studies, breastfeeding has been associated with a reduction in the risk of non specific gastroenteritis (Ip et al. 2007). It has also been reported that an increase in the duration of exclusive breastfeeding in infancy may have a long-term protective effect against chronic *H. pylori* infection and hence the risk of gastric carcinoma (Pearce et al. 2005).

Decreased risk of otitis media

Breast milk contains immunoglobulins and substances that decrease viral or bacterial adherence to tissue. Lack of breastfeeding may, therefore, increase the infant's risk for otitis media or ear infection (McNiel et al. 2010; Ip et al. 2007). The results of a global systematic review of 114 studies undertaken in 2012, identified exclusive breastfeeding for six months as one of the main factors in the prevention of acute otitis media and its complications (Monasta et al. 2012). One reason for the decreased incidence is purely mechanical, as the Eustachian tube is known to close as the infant breastfeeds, thereby preventing reflux of milk into the middle ear, which may lead to inflammation and subsequent blockage of the tube. Also, the position in which infants are typically held whilst breastfeeding may make them less likely to suffer from milk reflux than bottle-fed infants, who are more likely to be fed supine (Lawrence and Pane 2007). A review of epidemiologic studies indicates that the introduction of infant formula in the first 6 months of life is associated with increased incidence of acute

otitis media in early childhood. However, interpretations of findings are sensitive to the definition of breastfeeding used (Abrahams and Labbok 2011).

Decreased risk of allergies and asthma

Asthma is the most common chronic illness that affects children, with a particularly high prevalence in developed countries (Brew et al. 2012). The effect of breastfeeding on the risk of developing allergic diseases has frequently been studied and debated since the 1930's (Misak 2011), whilst the prevalence and severity of atopic manifestations in children has increased significantly over the last few decades. Ip and colleagues, (2007) reviewed the evidence on the effects of breastfeeding on short and long-term infant and maternal health outcomes in developed countries, and found an association between breastfeeding and a reduction in the risk of asthma in those subjects without a family history of asthma. This association was also found in subjects less than 10 years of age with a positive family history of asthma. This conclusion was confirmed by a later Swedish study that found a protective effect of breastfeeding up to 8 years of age (Kull et al. 2010). The Promotion of Breastfeeding Intervention Trial (PROBIT) is a cluster-randomized trial of a breastfeeding promotion intervention based on the WHO/UNICEF BFI. In this prospective study, 17 046 healthy breastfed infants were enrolled from 31 Belarusian maternity hospitals and their affiliated clinics. These were randomly divided into the experiment group of 16 hospitals with BFI training and the control group of 15 hospitals with routine breastfeeding training during 1996 and 1997 and included a long-term follow-up of 11.5 years. The results did not support a protective effect of prolonged or exclusive breastfeeding on asthma or allergy (Kramer et al. 2007b). There is also some evidence from cohort studies that breastfed infants have an increased risk of asthma and similar or increased risk of allergy (Sears et al. 2002; Wegienka et al. 2006).

In a review by McNeil et al. (2010), studies on the association of breastfeeding with atopic dermatitis yielded mixed results, some suggesting a protective effect, others showing no significant relationship. The International Study of Asthma and Allergies in Childhood (ISAAC)

investigated the relationship between breast feeding in infancy and symptoms of asthma, rhinoconjunctivitis and eczema in 6-7 year old children and found little evidence from cross-sectional analysis that breastfeeding protected against childhood eczema (Flohr 2011). Björkstén et al. (2011) conducted a global analysis of 31 countries investigating the relationship with breastfeeding in infancy and symptoms of asthma and concurred with these findings. Importantly, several studies have noted that research that uses large sets of data but which do not apply the same subject selection criteria, and use different definitions, make it difficult to define breastfeeding allergy relationships (Brew et al. 2012; Iyengar and Walker, W. A. 2012; Dieterich et al. 2013).

Decreased risk of childhood cancers

Despite a considerable body of epidemiological research, including two meta-analyses (Ip et al. 2009; Kwan et al. 2005), there is limited evidence linking breastfeeding and the risk of developing childhood cancers. Dieterich et al. (2013) believe this results from limited exploration of certain cancers, small sample sizes, reliance on long-term recall of feeding, conflicting or null results, and between-study heterogeneity of findings. The majority of childhood leukaemia is diagnosed as acute lymphocytic leukaemia (ALL). Ip and colleagues (2007) conducted a meta-analysis on the effects of breastfeeding on term infant outcomes in developed countries and found the published studies on childhood ALL to be equivocal. However, there is some evidence that breastfeeding may reduce the risk of developing ALL. Also, duration of breastfeeding may be important, as studies have reported that infants breastfed >6 months had a 24% (Kwan et al. 2005) and 19% (95% CI 9% to 29%) (Ip et al. 2007) reduction in risk compared to those not breastfed. These results account for known confounding variables, including socio-economic status. However, the role of biological factors, including via infectious exposures, remain unclear.

Decreased risk of obesity, hypertension, and cardiovascular disease

Breastfeeding may have a protective effect against infant obesity through two mechanisms; the components/composition of human milk and the behaviours related to infant feeding

(Dieterich et al. 2013). However, determining causal effects on health and disease from observational epidemiology studies is controversial because the association between breastfeeding and obesity is often limited by confounding evidence. The PROBIT trial observed no differences in overweight or obesity between the intervention and standard care groups (Kramer et al. 2007a). The British Avon Longitudinal Study of Parents and Children (ALSPAC) found evidence that longer duration of breastfeeding was associated with a reduced risk of fat mass in the top decile but not with obesity based on BMI thresholds (Toschke et al. 2007). However, the results of a study in Ireland in 2012 of 7798 children indicated that being breastfed for between 13 and 25 weeks was associated with a significant reduction (38%) in the risk of obesity at nine-years of age, while being breastfed for 26 weeks or more was associated with a significant reduction (51%) in the risk of obesity at nine years of age (McCrory and Layte 2012). There is also evidence that supports a dose-dependent association between longer duration of breastfeeding and decrease in risk of being overweight (Harder et al. 2005; Horta et al. 2007; Chivers et al. 2010). Ip et al. (2007) found that any breastfeeding is associated with a small reduction in systolic blood pressure later in life, which may in turn decrease the risk for heart attack and stroke. Increases in these cardiovascular disease parameters are related to increased risk for cardiovascular disease (heart attack) and stroke (Stuebe 2009). Horta et al. (2007) performed a meta-analysis that showed small but significant protective effects of breastfeeding on systolic and diastolic blood pressure. Conversely, the PROBIT trial observed no reduction in blood pressure at age 6.5 years in the experimental group (Toschke et al. 2007).

Decreased risk of sudden infant death syndrome (SIDS)

Sudden infant death syndrome (SIDS) is a rare, multifactorial diagnosis by exclusion that is the leading cause of post-neonatal death in developed countries. Whilst bottle-feeding has been proposed as one potentially modifiable risk factor for SIDS, it is difficult to clearly establish risk factors for the condition (McVea et al. 2000). Hauck et al. (2011) conducted a meta-analysis of 18 studies published between 1966 and 2009 to quantify and evaluate the protective effect of breastfeeding against SIDS, including the influence of exclusive

breastfeeding and longer breastfeeding duration. They found that, compared to formula-fed infants, those who were ever breastfed had a 45% reduction in SIDS risk, those breastfed ≥ 2 months had a 62% reduction, and those exclusively breastfed for any duration had a 73% reduction.

Decreased risk of diabetes

Type 1 diabetes mellitus is a condition in which autoimmune beta-cell destruction results in decreased levels of insulin. The incidence continues to rise across Europe by an average of approximately 3–4% per annum (Patterson et al. 2012). The cause of this autoimmune destruction is unknown, however the disease is thought to have both genetic and environmental components. Infant feeding is thought to play an important role as there is a proportionally greater relative increase in incidence in children less than 5 years old (Cardwell et al. 2012). The secretory immunoglobulin A antibodies and increased beta cell proliferation in breast milk may provide protection against the onset of Type 1 diabetes by conferring passive immunity and by delaying exposure to possible food antigens (Ip et al. 2007). In two systematic reviews, breastfeeding for three months or longer has been reported to reduce the risk of developing Type I diabetes when compared breastfeeding for less than three months or exclusive formula-feeding (Ip et al. 2007; Patelarou et al. 2012).

Lack of breastfeeding during infancy may also increase the risk for Type II diabetes in adulthood. Type II diabetes develops in people who experience insulin-resistance related to overweight, inactivity, and genetic factors (Delores et al. 2009). Whilst evidence on a possible programming effect of breastfeeding on glucose metabolism is sparse (Horta et al. 2007), it has been proposed that the polyunsaturated fatty acids contained in breast milk maintain adequate numbers of insulin receptors in the brain and thereby regulate long-term glucose and insulin metabolism (Das 2003). The benefits of breastfeeding have been attributed to bioactive substances, which promote the maturation of the immune system, reduce insulin resistance, and prevent excessive weight gain during childhood. A recent non-systematic review of 52 studies performed by Pereira et al. (2014) to investigate the influence of

breastfeeding as a protective agent against the onset of diabetes in children reported that, given the scientific evidence indicated in most published studies, the lack of breastfeeding can be a modifiable risk factor for both type 1 and type 2 diabetes.

2.1.3 Health Benefits of Breastfeeding Preterm or Low Birth Weight Infants

Infants born preterm, defined as births at <37 completed weeks of gestation, are at higher risk of mortality, morbidity, and impaired motor and cognitive development in childhood than infants born at term (Zeitlin et al. 2013). It is estimated that 11.1% of all live births in 2010 were born preterm (14.9 million babies), with preterm birth rates increasing in most countries. Addressing prematurity is an urgent priority for Millennium Development Goal 4, which called for a reduction of child deaths by two-thirds by 2015, and for a halving of deaths due to prematurity by 2025 (WHO 2012). Direct complications of preterm birth account for one million deaths each year, and preterm birth is a risk factor in over 50% of all neonatal deaths (Blencowe et al. 2013). Several factors have been identified in contributing to the rise in preterm births, including increased maternal age, increased rate in pregnancy-related complications such as gestational diabetes, greater use of infertility treatments leading to more multiple pregnancies, and more caesarean deliveries taking place before term (Edmond and Kirkwood 2006; Chang et al. 2013).

Preterm babies are nutritionally vulnerable because they are born with inadequate stores of all the major nutrients, including protein, energy, minerals and vitamins. As a result of prematurity they also have a reduced store of adipose tissue, a prime fuel supply for fully-grown infants, and as a result their primary store of energy is in the protein of their muscles and other organs. This vulnerable nutritional status leaves preterm babies at an increased risk of a number of conditions such as necrotising enterocolitis (NEC) and sepsis (Strodtbeck 2003). Careful management of their nutritional requirements is essential if their outcome is to be optimised (Embleton 2007) and feeding preterm infants human milk can confer significant short and long-term beneficial effects on health. Several major reviews exploring the role of human milk for preterm infants have reported shorter hospitalisation, fewer hospital

readmissions for illness in the year after NICU discharge and fewer serious infections and respiratory illnesses (Vohr et al. 2007; Ip et al. 2007; Renfrew et al. 2009b; Schanler 2011; Underwood 2013).

Decreased risk of necrotising enterocolitis

The preterm gut is particularly sensitive to injury due to the immaturity of all aspects of its function; the gut is unprepared for enteral nutrition due to an immature immune system, underdeveloped physical mucosal barrier, poor acid production, abnormal bacterial colonization and poor motility. Combined, these factors make the preterm bowel susceptible to injury from systemic ischaemia, acidosis or infection (Kim et al. 2013). Because preterm infants have more immature host defences, levels of breast milk phagocytes and secretory immunoglobulin A (sIgA) are higher in premature breast milk (Walker 2010).

Necrotising enterocolitis (NEC) is a gastrointestinal disease that mainly occurs among preterm infants and is a leading cause of infant mortality in the extreme preterm infant (<28 weeks) (Meinzen-Derr et al. 2009). It occurs in 3 to 10% of VLBW infants and is associated with increased mortality and morbidity, including growth and neurodevelopmental impairment. The pathophysiology of NEC is thought to involve a number of factors including: immaturity of the immune, circulatory and digestive systems, hypoxic-ischaemic injury, enteral feeding, and pathologic bacterial colonization (Thompson and Bizzarro 2008). Gut microbiota is altered by the type of feeding the newborn infant receives, i.e. breast fed infants get lactobacilli or bifidobacteria in comparison to formula fed infants that are colonized with enterobacteria and other gram negative organisms (Huda et al. 2014). This microbial colonization is thought to play an important role in the risk of NEC and therefore the role of human milk feedings in preventing NEC has long been recognised. In fact, breast fed infants are at a 6–10-fold lower risk of developing NEC compared to formula-fed infants (Sisk et al. 2007; Schanler et al. 2013)

Whilst limited studies suggest that diet may have less of an effect on the composition of the intestinal microbiota in the premature infant than other factors (such as antibiotic

administration) (Underwood 2013), for extremely premature infants, an exclusively human milk-based diet is associated with significantly lower rates of NEC (Sisk et al. 2007; Sullivan et al. 2010; Cristofalo et al. 2013; Khader et al. 2013; Herrmann and Carroll 2014). Meinen-Derr et al. (2009) substantiate and expand the pool of evidence, suggesting an inverse relationship between the cumulative amount of human milk an infant receives and the subsequent risk of NEC or death. A reduction in NEC rates has wider reaching implications as this also leads to lower mortality rates and lower rates of long term growth failure and neurodevelopmental disabilities. Furthermore, a diet of human milk improves feeding tolerance and hastens the attainment of full enteral feeding.

Decreased risk of sepsis

Late-onset sepsis occurs in approximately 22% of VLBW infants in the USA, making it one of the most common morbidities in this population (Fanaroff et al. 2007). Breastmilk contains bifidus factor that stimulates the growth of *Lactobacillus bifidus*, originally described as a prebiotic, which helps to create the optimal microbial flora in the gut. This helps to fight infection because it serves as a metabolic substrate for desired bacteria, and shapes an intestinal microbiota composition. Oligosaccharides are known to act directly on preventing pathogen adhesion to infant mucosal surfaces, thereby lowering the risk for infections, and modulating epithelial and immune cell responses (Bode 2012). A recent study by (Patel et al. 2013) demonstrated a significant dose-response relationship between the early dose of human milk received by VLBW infants on both clinical and economic indicators. Another study looking at this vulnerable population showed a positive effect of breastfeeding, i.e. a 9% reduction in late onset sepsis (Vohr et al. 2007) and several reviews have supported this evidence (Stuebe 2009; McNeil et al. 2010; Schanler 2011; Underwood 2013). Skin-to-skin contact also plays a valuable role as it is needed for the functioning of the entero mammary system: when the mother performs skin-to-skin holding of her infant, she is exposed to the pathogens of the neonatal intensive care unit (NICU). As a result, she makes specific antibodies that can then be transferred to the infant via her breastmilk (Furman and Kennell 2007).

Decreased risk of retinopathy of prematurity

Retinopathy of prematurity (ROP) is a developmental disorder of the retinal blood vessels and is the most common, serious ophthalmic disease in preterm infants that can lead to blindness in advanced stages. Premature birth leads to the disruption of retinal development and can result in an incompletely vascularized retina, whilst supplemental oxygen to treat premature infants may cause abnormal vessel growth in the retina. The abnormal vessels are fragile and often haemorrhage into the eye, which is followed by scar tissue development and consequently by retinal detachment (Okamoto et al. 2007). Early postnatal infant nutrition can affect oxidant balance and may affect ROP development (Johnson et al. 2003). Studies examining the protective effect of breastfeeding against ROP have had inconsistent results. Studies by (Furman et al. 2003; O'Shea et al. 2008; Kao et al. 2011) report that human milk intake is not associated with a decreased risk of severe retinopathy of prematurity in VLBW infants. However, in vitro chemical analysis of antioxidant content consistently shows human milk contains greater antioxidant properties compared to formula and this is believed to protect preterm infants with immature antioxidant systems, who are exposed to high oxygen environments and are at higher risk for oxidant injury (Aycicek et al. 2006). A study by Hylander et al. (2001) reports human milk feeding among VLBW infants as being associated with a lower incidence of ROP compared to exclusively formula fed VLBW infants, after adjusting for confounding variables. Porcelli and Weaver (2010) also found exclusive maternal milk feeding since birth may prevent ROP of any stage in the NICU. The possibility that exclusive fresh maternal milk feeding since birth may prevent ROP of any stage in VLBW infants in the NICU deserves further research.

Pain control

Infants that are born preterm undergo numerous tissue damaging injuries as part of their clinical care. It is known that their sensory modalities are severely over-stimulated, compared to exposure to stimuli in utero, and consequently the pain that they experience may have profound and long lasting effects (Johnston et al. 2011). Breast milk is a safe and natural

agent for reducing the pain of neonates and can be given orally via syringe or breastfed during a procedure (Foster et al. 2013). Breast milk odour has also been found to have an analgesic effect in preterm newborns and can be used as a safe method for pain relief (Badiie et al. 2013). A recent systematic review of 20 studies that evaluated the effectiveness of breastfeeding or supplemental breast milk in reducing procedural pain in neonates concluded that, if available, breastfeeding or breast milk should be used in neonates undergoing a single painful procedure rather than placebo, positioning or no intervention (Shah et al. 2012).

Improved neurodevelopmental outcome

Breast milk has been shown to promote neurological development and cognitive skills (Michaelsen et al. 2009; Isaacs et al. 2010; Jedrychowski et al. 2012; McCrory and Murray 2013). In the UK, breastfeeding is associated with improved cognitive development, particularly in white, singleton children born preterm (Quigley et al. 2012). Further studies have reported improved neuro behavioural outcomes, particularly motor skills, in preterm infants using Bayley Mental Developmental Index and Behaviour Score (Feldman and AI 2003; Vohr et al. 2007). In an observational cohort study of 2925 very preterm babies Rozé et al. (2012) assessed the relationship between breastfeeding at time of discharge, weight gain during hospitalisation and neurodevelopmental outcome. They describe the outcome of observed better neurodevelopment, in spite of suboptimal initial weight gain, as the 'apparent breastfeeding paradox' in very preterm infants. This is because poor growth has been associated with later cognitive dysfunction.

Psychological outcomes

An important aspect of human milk feeding is the potential for greater mother-infant attachment. The experience of having a baby in the NICU interferes with initial bonding and attachment (Shaw et al. 2009), and has been shown to influence the production of breast milk (Lee, Lee and Kuo 2009). The psychological benefits of providing breast milk for infants on NICUs is consistently documented in the literature (Flacking et al. 2006; Edmunds and

Nevill 2008; Swanson et al. 2012; Rossman et al. 2013); and the provision of milk symbolises the continuation of the unique biological connection between the mother and her infant that began during pregnancy (Rossman et al. 2013). Feelings of attachment, maternal empowerment, and confidence are enhanced when a mother is able to provide breast milk for her infant (Callen and Pinelli 2005; Tharner et al. 2012). The importance of feelings of self-efficacy cannot be underestimated as this helps mothers persevere through the challenge of having to sustain an adequate milk volume by means of long-term use of a breast pump (Wheeler and Dennis 2013).

2.1.4 Economic Benefits of Breastfeeding

A UK study analysed the health service costs incurred as a result of treating diseases resulting from not breastfeeding, including costs in both primary and secondary care. It found that over £17 million could be saved annually by avoiding the costs of treating three acute diseases: gastrointestinal infections, lower respiratory tract infections and otitis media in infants, and increasing breastfeeding prevalence further, would result in even greater cost savings Renfrew et al. (2012). This savings figure is set at \$13 billion per year for the USA, if 90% of families breastfed exclusively for 6 months (Bartick and Reinhold 2010), and it is estimated that the total cost of VLBW infants born in the US each year is more than \$9 billion.

Within the NICU setting, reaching full feeds faster with the use of human milk means fewer days of intravenous infusions (IVs), fewer side effects from total parenteral nutrition (TPN), fewer infections and infiltrations from IVs, and less costly and fewer hospital days (Schanler et al. 1999; Gartner et al. 2005). There is also a dose response relationship between the proportion of the total milk intake that is breastmilk and a disease protective effect (Patel et al. 2013; Vohr et al. 2006). Because human milk has been shown to reduce both the incidence and severity of some morbidities in VLBW infants, such as NEC, bronchopulmonary dysplasia and late-onset sepsis, it has an indirect impact on the cost of the NICU hospitalization (Patel et al. 2014) and may also reduce hospitalisation rates (Vohr et al. 2007;

McNiel et al. 2010). The incremental cost incurred from an episode of sepsis or NEC involves the additional disease-specific cost of treatment, the additional cost due to increased length of stay in level one, two, and three units, and the additional cost due to lifetime disability. In the US Neville et al. (2012) report that savings of over \$1 billion per year could be realised if feeding human milk resulted in a reduction in the incidence of NEC and other serious medical problems by even 15%. In the UK, economic analysis showed that approximately £2.3 million per annum could potentially be saved in treating NEC in infants in neonatal units if exclusive breastfeeding/breastmilk rates at discharge increased from 35% to 50%. A further increase to 75% could increase savings to £6 million per year and these savings could increase to £10 million per annum if rates at discharge increased to 100% (Renfrew 2012). However, It is also important to note that there are other economic considerations, such as those outside of the health sector. For instance, the cost to the education sector for cognitive deficit that should be considered when estimating cost benefits of breastmilk feeding in the NICU (Patel et al 2013).

2.1.5 Alternatives to Breastfeeding

The onus is now on health-care professionals to carefully assess the efficacy and safety data on products that they use to meet the nutritional needs of the infants in their clinical care. Products such as specialised and standard infant formulas have the potential to affect health outcomes differentially, and this knowledge raises a new requirement to consider more broadly the impact of nutritional practices. A separate line of research also suggests that the presence of bovine products (not merely the absence of breast milk feedings) negatively affects intestinal permeability and gut colonization making the relationship between breast milk feedings and morbidities even more complex (Meier et al. 2013).

The use of donor milk as a substitute for human breast milk is an important area of research as human milk banks are now increasing in popularity. One study in the US randomised 243 extreme preterm infants to receive either pasteurized donor milk or preterm formula if the supply of their own mother's milk became insufficient in the period from birth to 90 days of

age or hospital discharge. Caregivers were blind to the group assignment. Results showed that as a substitute for mother's own milk, pasteurized donor human milk offered no observed short-term advantage over preterm formula and reiterated the benefit of mothers' own milk for extremely premature infants, as this group had fewer infection-related events and shorter hospital stays (Schanler et al. 2005). Another study has shown poorer weight gain when giving donor compared to mothers own milk (Montjau-Régis et al. 2011). As storage and heat processing significantly diminish the advantages of non-nutrient components in human milk efforts should be made to use mother's own milk (Heiman and Schanler 2006).

Research has shown that even in developed countries, health outcomes differ substantially for infants who formula feed, compared with those who breastfeed. In order to enhance the chances of discharging infants from hospital exclusively breastfeeding, mothers require support, advice and education. In order to do this there must be good clinical education and support for staff. Klingenberg et al. (2012) highlight enormous variability in neonatal feeding practice and the need for evidence-based enteral feeding strategies that optimise enteral nutrition (both in hospital and after discharge). It is known that where feeding practices are not evidence-based and units do not have written feeding guidelines, standardisation of feeding guidelines based on current evidence and international nutrition recommendations may be beneficial (Cormack et al. 2012; Maastrup et al. 2012).

2.1.6 Conclusion

The literature describing associations between breastfeeding and various health outcomes for infants is vast, and has only been summarised here. Overall, studies indicate that feeding human milk to all infants, and to preterm infants in particular, confers nutritional, gastrointestinal, immunological, developmental, and psychological benefits. These benefits impact positively on both the term and preterm infant's long-term health and development. Moreover, several national and international organisations (UNICEF, World Health Organisation and The UK Department of Health) have concluded that breastfeeding is the

optimum way to feed infants and have taken steps to promote breastfeeding. However, whilst there is good evidence quantifying the adverse health effects of not breastfeeding and not being breastfed, good quality research demonstrating the protective effect of breastfeeding is limited. This is due to the ethical issues relating to randomised controlled trials in infant feeding and the low prevalence of exclusive breastfeeding. Major limitations have been identified in studies such as the differences in the definition of exclusive breastfeeding across the studies. Some studies define the exclusive breastfeeding groups as “not receiving any formula”, which could suggest these groups might have been introducing nonformula supplements such as water to their infants, further underestimating the effect of completely exclusive breastfeeding (McNiel et al. 2010). A further important aspect of this analysis is the ability to control for confounding variables, such as socio-economic status, education or other systematic differences between women who breastfeed and those who do not (Renfrew et al. 2012). Future research with more precise and consistent definitions of feeding that pay attention to distinctions between direct breastfeeding and human milk feeding by bottle could further confirm the potential benefits of breastfeeding.

Section 2 - Background Literature to Support and Inform the Development of the eLearning module

2.2.1 Background

In order to design effective training for clinicians it was essential to be fully informed of the most recent evidence for breast milk expression and the physiology of breast milk production. It was on the basis of this information that the content for the eLearning module was developed. This section describes the literature that supports current practices and the educational intervention.

2.2.2 Lactogenesis

Successful milk production is normally the result of a joint effort between the mother-infant dyad, but in the case of preterm birth where the infant is unable to feed at the breast, the mother has to attempt to initiate, establish and maintain a milk supply alone. When the mother and the infant are separated, the infant is not available to stimulate the breast for purposes of breastfeeding and less-frequent stimulation is known to lead to reduced milk production. The reasons for lower production rates of milk among preterm mothers are complex. Breast milk production is dependent upon hormonal changes that occur naturally when giving birth and placing a child to the breast to feed. Lactogenesis is the term used to describe the initiation of lactation; the process of functional differentiation that mammary tissue undergoes in order to change from a non-lactating to a lactating state. The production of breast milk occurs in 3 stages. Lactogenesis stage I is the first stage and occurs between the 10th and 22nd week of pregnancy. During this period the mother's body produces higher levels of prolactin (a hormone that stimulates milk production) breast size increases and the mammary gland is able to secrete colostrum (Riordan and Wambach, 2010). This is important because it means that the mothers' breasts, regardless of how preterm their infant is born, are already preparing for lactation. Stage II describes the onset of copious milk secretion that occurs 30–40hr after birth and begins when the mother expels the placenta. This causes the

mother's oestrogen and progesterone levels to drop dramatically, allowing prolactin to stimulate the mother's body to produce milk, independent of infant stimulation. However, during stage II, when the baby stimulates the breast during feeding, or the mother stimulates the breast when pumping, more prolactin receptor sites are created in the mother's breast. Stage III is the establishment of a mature milk supply (Hartmann et al. 2002). At this stage, milk secretion is essentially governed by the stimulation of the breast.

Volume/frequency of expression

Establishing and maintaining a milk supply for a preterm infant is usually an entirely mechanical process that may have little input from the baby. Therefore, in order to be successful, the mother has to overcome many barriers and 'persuade' her body to produce enough milk to feed a healthy term infant. Whilst there is not a great deal of empirical evidence, factors that can positively impact on the success of initiating and maintaining lactation in NICU include early and frequent expression (Furman et al. 2002; Hill and Aldag 2005; Callen and Pinelli 2005; Becker et al. 2011; Heon et al. 2014; Maastrup et al. 2014b). Guidelines for initiation of expression suggest that a mother should express within 6 hours of delivery in order to avoid a delay in Lactogenesis II (Nyqvist et al. 2013). However, mothers of VLBW infants are often in a critical clinical condition and therefore the initiation of milk expression is delayed (Hill et al. 2005a; Maastrup et al. 2014a). The importance of early expression has been further highlighted by Parker et al. (2015) who recently performed a study in which 41 mothers of VLBW infants were grouped into those who initiated expression within 6 hours, and those who initiated > 6 hours and found that lactation success was not improved unless they initiated expression within the first hour of birth. This finding concurs with their results from an earlier, smaller randomised study of 20 women of VLBW infants (Parker et al. 2011).

In order to establish a good supply of milk, mothers are encouraged to express at least 8-10 times a day, reducing to 6 to 8 times a day to maintain milk supply (Kent et al. 2012). This is

because milk constituent synthesis is regulated by an autocrine mechanism via the milk protein FIL (feedback inhibitor of lactation). FIL is concentration-dependent, suggesting that milk accumulation and removal is accompanied by cyclical changes in inhibitor accretion and depletion in milk (Wilde et al. 1998). As a result of this, the rate of milk synthesis is directly related to the degree the breast is drained during feeding or milk expression (Daly et al. 1996). Consequently, mothers should be advised to express until they have drained their breast thoroughly in order to maintain a good milk supply.

In preterm birth there may be a delay in lactogenesis II because the breast is not as fully developed for lactation as in a term pregnancy. It may take several days to 2 weeks for a mother to establish her milk supply (i.e. start producing between 440 and 1220 mL daily), and regular and frequent breast stimulation and emptying is critical during this time. Hartmann and colleagues identified that mothers have differing breast storage capacities. Consequently, those mothers who have a large storage capacity (>250 mL per breast) and who can easily drain their breasts almost completely may be able to decrease pumping frequency to 4 times per day. However, mothers who have small storage capacity (<100 mL per breast) or who have difficulty draining their breasts with an electric pump may need to maintain a pumping regimen of 8 times per day (Hartmann et al. 2003).

Volume – predictive of future success

Research indicates that milk output during the first 2 postnatal weeks predicts the adequacy of milk volume during the late NICU hospitalization. A US study (Hill 2005) measured the average milk output for postpartum days 6 and 7, to see if this was a predictor for milk adequacy at week 6 postpartum. The study compared this measurement between mothers of preterm infants (≤ 31 weeks) who used mechanical expression, with mothers of a singleton healthy term infant who fed at the breast. The results suggest that mothers who mechanically express milk for their non-nursing preterm infant are at 2.8 times greater risk of low milk volume (less than 500 mL/d), when compared with mothers of healthy term breastfeeding infants. The expression of at least 500 mL/d during the first 6 weeks

postpartum was also characteristic of mothers who provided their own milk at 12 weeks. A qualitative, longitudinal study that interviewed 64 mothers of VLBW infants concurred with these findings, suggesting that low milk volume is the greatest barrier to breastfeeding at discharge (Callen et al. 2004).

Whilst in NICU, infants often only require small volumes of milk during the early stages of their care. It is, therefore, important that both the mother and staff understand that there are two milk volume targets to focus on from the outset of production. Primarily, that there is enough milk produced for their infant in the NICU at the time, which may be very small amounts because of prematurity, surgical complications, or fluid restrictions; and secondly the importance of protecting the milk supply for future feeding requirement. Protecting the milk supply translates into minimal milk volumes of 350 mL per day (adequate for 2kg infant at discharge), and volumes closer to 1000 mL per day to ensure enough milk even if mothers experience later problems with their milk supply (Meier et al. 2013). Using a record of milk production has also been shown to be useful in helping mothers pump regularly and build a good milk supply (Spatz 2004).

2.2.3 Factors that support breast milk expression in a NICU context

Breast pump equipment

Expressing breast milk several times a day takes considerable time and is a major commitment for mothers who may have other responsibilities or considerable distances to travel in order to visit their baby. One possible way of reducing the amount of time spent breast pumping would be to pump both breasts simultaneously. Simultaneous breast expression has been shown to stimulate more milk ejections and be a more efficient and efficacious method of expression, yielding milk with a higher energy content (Hartmann et al. 2012). In the UK, Jones et al. (2001) performed a randomized controlled trial of sequential and simultaneous breast pumping on volume of milk expressed and its fat content and also to measure the effect of breast massage on milk volume and fat content. A total of 36 women

were divided into those that used simultaneous pumping (n=19) and those that used sequential pumping (n=17). Both simultaneous breast pumping and massage increased the fat content of the milk and simultaneous breast pumping alone increased the milk yield. However, a Cochrane review of 23 randomised controlled studies (Becker et al. 2011) found no evidence of difference in volume with simultaneous or sequential pumping, or between manual and electric pumps studied, although they caution that due to small sample sizes, large standard deviations, the small number of studies reviewed, and the diversity of the interventions argue that results cannot be applied beyond the specific method tested in the specific settings.

The design and function of breast pumps can have an impact on the mothers' success in expressing milk (Meier et al. 2008). The same authors later performed a randomized clinical trial of 105 mothers of premature infants to compare the effectiveness, efficiency, comfort and convenience of newly designed breast pump suction patterns (BPSPs), that mimic sucking patterns of the breastfeeding human infant during the initiation and maintenance of lactation (Meier et al. 2012). The study found that BPSPs that mimic the unique sucking patterns used by healthy-term breastfeeding infants during the initiation and maintenance of lactation are more effective, efficient, comfortable and convenient than other BPSPs. Other studies, that have been funded by breast pump companies, have focused on either comparing standard breast pumps (Burton et al. 2013) or trialling a specific make and model (Larkin et al. 2013) and have found no difference in their effectiveness in the NICU setting.

An Australian study provided evidence for a possible mechanism for improving the efficiency of breast milk removal by measuring the effect of temperature on the diameter of the milk ducts in the nipple that may control of the flow rate of milk. Kent et al. (2011) assessed the effect of using a warm breastshield on the efficiency, effectiveness, and comfort of expressing milk with an electric breast pump on 25 mothers. Mothers made spontaneous comments regarding comfort, and 17 were asked to rate the comfort of the warm shield on a scale of 1 (very uncomfortable) to 5 (very comfortable). The use of a warm breastshield with

an electric breast pump was found to be comfortable and improved the efficiency of milk removal. The warm breastshield also decreased the time taken to remove 80% of the total milk yield, and increased the percentage of available milk removed after 5 minutes of expression. There was no change in the percentage of available milk removed after 15 minutes of expression compared with an ambient-temperature breastshield.

Tactile stimulation

Whilst it is important to establish a good milk supply through effective breast milk expression techniques, it is also essential that mothers are encouraged to put their preterm baby to the breast. Mothers and preterm infants can also experience difficulties with the transition from expressing to breastfeeding. In the US, Pineda (2011a) investigated the relationship between direct breast-feeding (infant sucking directly from the breast) and duration and success with breast milk feedings until discharge in 66 premature infants. Positive associations were found between breastfeeding at discharge and mothers putting their infants directly to breast in the NICU. Tactile stimulation from the baby has been shown to help the mother with both milk production and to allow the release of milk from the breast, known as the 'let down reflex' (Becker et al. 2011). This can be achieved either by putting the baby directly to the breast or by kangaroo care (KC), whereby the baby is placed on the mothers chest. Provision of KC is one of the "ten steps to successful breastfeeding" outlined in the BFHI, as it has been associated with a higher breastfeeding rate, increased breast milk production, a lengthening in the duration of lactation and improvement in exclusivity of breastfeeding in hospital and during follow up (Renfrew et al. 2009a).

Nurse lactation specialist

Nurse lactation specialists can enhance mothers' success in a variety of ways, including education, emotional support, providing positive feedback regarding infant growth and condition, instruction in the use of breast pumps, and encouraging skin-to-skin care (Castrucci et al. 2007). In the UK, Smith and Embleton (2013) used a single full time member of staff to implement a number of interventions to improve breast milk provision on the

NICU. A snapshot survey of breastfeeding initiation and numbers of mothers still successfully expressing at 14 days (D14) was conducted over a 6-week period. Results showed initiation rates rose from 76%, when there was no additional staff member, to 90% during the time the staff member was attached to the NICU, and rates were maintained for the following 12 month period. D14 rates increased significantly from 18/40 45% to 54/69 89% (of those initiating) and discharge rates showed an insignificant rise from 12/40 30% to 144/263 54%. However, as this study was a composite of audit, review and QI and it is not possible to attribute or quantify which aspects of the process resulted in the greatest benefit. This study does, however, indicate that the addition of a nurse lactation specialist, who can lead quality improvement interventions within NICU, can contribute to breastfeeding success, as has been found in other multi-faceted, quality improvement studies of this type (Battersby et al. 2014; Husebye et al. 2014; Dereddy et al. 2014).

Relaxation techniques

The use of a breast pump can be seen as a mechanical and unnatural way to extract milk, and therefore an unusual stimulus for a mother to trigger the milk ejection reflex. The hormone oxytocin is required in order to stimulate the milk ejection reflex, and oxytocin is released through the stimulation of the mothers' senses such as touch, smell and sight. In order to enhance milk ejection, relaxation techniques can be used (Becker et al. 2011), along with having the infant close by for the expression sessions, or placing the infant on one breast while expressing milk from the other breast. If the mother is separated from her infant, the use of a cue such as a photograph may help her to visualize her infant to stimulate milk ejection (Kent et al. 2012). As discussed, some studies have identified stress as an inhibiting factor in the production of milk, and therefore interventions that could help the mother to relax have been explored. A US study by Keith et al. (2012) examined the effects of listening and visual interventions on the quantity and quality of breast milk produced by mothers, using a double electric breast pump. In this trial 162 mothers of preterm infants were randomly assigned to 1 of 4 groups, including a standard control group and 3 experimental groups who additionally listened to a recording of 1 of 3 music-based

listening interventions, while using the pump. The interventions for the experimental groups were firstly a verbal protocol, secondly a verbal protocol with guitar lullaby music added to the guided imagery section and lastly a verbal protocol with guitar lullaby music added to the guided imagery section along paired with visual images of the mother's infant. Results showed that mothers in the experimental groups produced significantly more milk than those in the control.

Galactagogues

Galactagogues are pharmacological interventions that typically increase prolactin levels and thus initiate the breast milk letdown reflex, but they may also aid in breast milk ejection (Nice 2015). If the maternal concentration of prolactin is inadequate, administration of domperidone may increase milk supply (Knoppert et al. 2013). Domperidone has few, if any, side effects and minimal or no effect on the concentrations of macronutrients (Kent et al. 2012). A Canadian study by Campbell-Yeo et al. (2010) examined the effect of domperidone on the nutrient composition of breast milk from 46 mothers of preterm infants (<31 weeks gestation). Mothers were randomly assigned domperidone or a placebo and the results found the composition of milk was unaltered, whilst the breast milk volume in the within-subject domperidone group increased steadily from a 60% increase on day 2 to a 267% increase by day 14. However, no published data support duration of use longer than 2 weeks (Anderson 2012). Whilst it is hoped that good maternal education about methods of improving milk supply may obviate the need for galactagogues, they can be considered a viable and reasonable choice for mothers who have exhausted other methods of support.

2.2.4 Factors that inhibit breast milk expression in NICU context

To understand the suboptimal breast milk feeding rates for premature and sick neonates, it is necessary to explore the barriers to breastfeeding. Through gaining an understanding of these barriers, appropriate interventions can be developed and implemented in order to facilitate the improvement of practices.

Emotion/stress

The process of providing milk to premature infants is different in several ways from the process that mothers of term infants experience, and as a result can be more difficult. Likewise, the experience of having to express milk long term is both physically and emotionally challenging. The stress that mothers experience following a premature birth is multifaceted and may include concerns about their premature infant as well as their own health. Hill et al. (2005b) found mothers of premature infants to be 3 times more likely to experience clinically significant psychological distress than those of the normative population. A number of studies have described how the emotional health of the mother is a factor that may impact on the ability for lactogenesis II to occur (Shaw et al. 2006; Schanler et al. 2007; Lasiuk et al. 2013). Stress may affect lactation through physiological or hormonal responses that prevent the development of milk, milk release and/or maternal behaviour. Using The State-Trait Anxiety Inventory (STAI) (Spielberger 1989), the Edinburgh Postnatal Depression Scale (EPDS) (Areias et al. 1996) and the Psychological Stress Measure (PSM) (Lemyre and Tessier 2003), an Italian prospective case control study (Zanardo et al. 2011) compared 42 mothers of term neonates with 42 mothers of singleton neonates delivered late preterm (34-37 weeks gestation), and found anxiety, depression, and stress levels of mothers who delivered late preterm were all significantly higher. In addition, delivering a late preterm baby was the most significant independent risk factor for early at-breast feeding failure.

A US study Sisk (2006) measured stress and anxiety levels of mothers (n=196) of VLBW infants. The group were divided into those that initially planned to formula (IFG, n=81) and those that planned to breastfeed (IBG, n=115) and were approached within 3 days of giving birth. Sisk et al also aimed to determine whether the counselling caused this group of mothers to change their plans to provide breast milk and, if so, how much milk they went on to produce. Maternal anxiety was measured using the State-Trait Anxiety Inventory (STAI) (Spielberger, 1989), which was administered to mothers before and after the initial counselling session on infant health benefits, collection and storage of milk and breast pump

procurement. Maternal stress was measured after counselling with the Parent Stressor Scale: NICU. Those who chose to breastfeed were provided with on going lactation consultant support and all mothers repeated the STAI every 2 weeks until their infant was discharged. The results showed no significant differences between groups in STAI scores either pre/post counselling or post counselling and state anxiety declined during the first 6 weeks of hospitalisation in both groups. After lactation counselling, 100% of the IBG and 85% of the IFG initiated breast milk expression. However, breast milk intake was greater (ml/kg/day) in the infants of mothers in the IBG compared with the IFG. Both groups of mothers reported low milk supply, returning to work or school, and the inability to pump as often as needed as the most common reasons for ceasing milk expression. Almost all of the mothers reported that breast pumping was worth the effort (IBG 100%, IFG 87%), and 100% said that they were glad that the staff helped them with milk expression. This study demonstrates that mothers are receptive to lactation counselling and able to provide breast milk for their VLBW infants and that lactation counselling mothers of VLBW infants increases the incidence of lactation initiation and breastfeeding without increasing maternal stress and anxiety.

In a sample of 32 US women with varied prenatal infant feeding intentions, Sisk et al. (2010) sought to identify patterns of factors that supported or hindered initiation of breast milk expression and maintenance of breast milk production after the birth of a VLBW infant. In-depth interviews with mothers who had been encouraged to initiate breast milk expression were conducted between 1 and 6 months post delivery. Maternal health complications, increased anxiety regarding their infant's health, and lack of privacy were all attributed as barriers to the initiation of milk expression. After hospital discharge, using manual or small electric breast pumps, travel to the neonatal intensive care unit, return to work, and difficulty with time management were perceived to have interfered with the maintenance of breast milk production. Family support, positive attitudes toward pumping, and anticipation of breastfeeding were perceived to have supported the maintenance of breast milk production. These findings are supported by other studies that have interviewed mothers regarding their experience of breastfeeding on NICU (Alves et al. 2013; Pereira, Alfenas, & Araújo, 2014)

These studies suggest that maintaining and protecting maternal wellbeing is important for the success of lactation, and that support may play a role in alleviating some of the stress. An integrative review that included 45 articles was performed by Lucas et al. (2014) to gather information describing not only the educational support but also the emotional support provided to mothers who pump breast milk while their infants are resident on NICU. In this review, several studies identified that mothers who perceived positive support and educated encouragement from the healthcare providers developed greater motivation, knowledge, and perseverance for pumping and transitioning to breastfeeding.

Lack of Privacy

Lack of privacy has also been associated with stress in NICU. Studies in the US have shown that the introduction of single family rooms (SFR) in NICU have resulted in parents feeling that they have more privacy within the hospital environment (Harris et al. 2006; Carter et al. 2008). Dowling et al. (2012) focused on the impact that a private room made on the experiences of 40 mothers, and developed a 23-item tool entitled 'My Experiences With Milk Expression for My Baby' that measured outcomes of provision of mothers' milk before and after SFRs were implemented on a NICU. Whilst this study was underpowered and produced non-significant findings, there was an increase in the percentage of mothers (n=40) who expressed milk in the infant's room (14.3% to 48%). However, mothers in the SFR stated that they continued to prefer breast pumping in their homes, citing the benefits of enhanced privacy and control over the environment found in the home when compared with the NICU. Mothers also described how being in a private room meant they had concerns about being interrupted whilst breast pumping, and this made them feel uncomfortable. The frequency of breast pumping did not increase in the SFR NICU, which may also reflect the mothers' discomfort.

Glucocorticosteroid

Premature babies may be born with under-developed lungs and an inability to produce surfactant, and this can result in respiratory disease. To try to reduce the risk of this outcome, pregnant mothers with threatened premature delivery prior to 34 weeks are often administered at least one course of glucocorticoids, a steroid that crosses the placental barrier and stimulates the production of surfactant in the fetal lungs (Grier and Halliday 2004). An Australian study by Henderson et al. (2008) investigated the effect of preterm birth and antenatal corticosteroids on the timing of Lactogenesis II after birth. Results showed that delivery at extremely preterm gestational ages (< 28 weeks) was associated with a significant delay in the onset of lactogenesis II. The volume of milk was less in mothers when antenatal corticosteroids were administered between 28 and 34 weeks' gestation and delivery occurred 3 to 9 days later. It is therefore important to provide women with a high-risk pregnancy with education about the likelihood of delayed lactogenesis and support to overcome this.

Caesarean section and obesity

Unplanned caesarean birth has been shown to be a risk factor for delayed onset of lactogenesis II (Chapman et al. 2001). Independent of delivery method, maternal obesity is also a risk factor for delayed onset of Lactogenesis II (Hilson et al. 2004). Obese women are also more likely than normal-weight women to have a caesarean delivery (Weiss et al. 2004). A US study by Leonard et al. (2011) used a postal questionnaire to collect information from 2288 breastfeeding women who had delivered well, term babies. Analysis focused on how breast milk expression affects breastfeeding and whether overweight or obese women, who have less breastfeeding success than normal-weight women, express milk differently. Results showed that breast milk expression potentially reduced differences between BMI categories in the duration of breastfeeding and supported longer durations of breastfeeding. This study suggests that some of the problems that obese women may find with breastfeeding, such as latching on and positioning, may be ameliorated by breast milk expression.

2.2.5 Potential Adverse effects Associated with Breast Milk Pumping

Sepsis

In order to minimise the risk of breast milk induced infection in susceptible newborns, it is important that mothers are made aware of the importance of hygiene with regards all aspects of milk expression. Possible adverse affects from expressing milk include injury to the mother and bacterial contamination that may affect the baby. Mother's milk is not sterile and can be a vehicle for commensal and pathogenic microorganisms derived from the mother or the NICU environment. Breast milk that undergoes expression, collection, storage, warming, and feeding is subjected to environmental pathogens and temperature changes that can compromise its nutritional, immunologic, and microbiological integrity (Meier et al. 2013). Therefore, strict hygiene and careful temperature and time control are essential when collecting, storing and delivering expressed milk to infants.

A number of reports have suggested an association between breast milk and neonatal sepsis (Byrne et al. 2005; Gagneur et al. 2009; Widger et al. 2009; Davanzo et al. 2013). Other research in this field has countered these claims. In the US, Schanler et al. (2011) collected fresh, mechanically expressed breast milk from mothers (n=161) who delivered preterm (<30 weeks gestation) and analysed it for microbial flora and presumptive microbial species. These were then compared with pathogens isolated from the same infant's blood, cerebrospinal fluid or urine. The results showed that although certain isolates appeared sporadically, and suggested common exposure of both mother and infant, random milk cultures were not found to be predictive of infection in premature infants. Overall these data suggest that routine milk cultures do not provide sufficient data to be useful in clinical management. Further to this, a Belgian study by Cossey et al. (2011) demonstrated that the pasteurisation of milk offered no benefits with regards the reduction of laboratory-confirmed sepsis in raw milk.

Existing scientific literature on the subject of routine milk cultures is scarce and there is no general consensus. However Cossey et al. (2011) reinforce the message that NICUs must be committed to the highest standards of self-regulation that are practically and scientifically warranted. They go on to suggest that there is a need for agreement regarding the requirement for bacteriological screening of milk and the appropriate response to positive cultures or to the need for pasteurization. This may include situations where there are recurrent episodes of sepsis with the same organism in a single patient, occurrence of sepsis with the same organism in siblings (twins, triplets), or late-onset sepsis and clinical symptoms of mastitis in the mother, such as is used in the 'best practice' approach proposed by Davanzo et al. (2009). It would appear that routine surveillance culture of expressed milk is costly, of little clinical value and may be detrimental to this goal. Rather, the focus should remain on strict hygiene whilst expressing, storing and providing the infant with breast milk.

Breast pumping equipment

Improper use of an electric pump can lead to mastitis, trauma, and nipple wounds (Clemons and Amir 2009; Brown et al. 2005; Flaherman et al. 2014). Breast shields that are too tight compress the milk ducts during pumping and do not permit the release of milk via the normal milk ejection and pump suction pressures, whereas shields that are too large draw too much of the mother's areola into the tunnel, leading to oedema in the tissues and subsequent compression of milk ducts (Patel et al. 2010). In either case, the results of an incorrectly fitted breast shield are nipple trauma and areas of the breast that do not empty appropriately. Because nipple plasticity and degree of areolar oedema change over the early postpartum period, a mother may require different sizes of breast shields to remove milk effectively and comfortably. Women may also need different sizes of shields for the left and right breasts.

Relactation

If a mother finds that her milk supply has diminished or ceased she may need to undergo a process of relactation in order to re-establish her supply. Successful breastfeeding after

induced lactation has been reported in non-Western cultures (Agarwal and Jain 2009). Factors critical for success included motivation, positive attitude, frequent stimulus from suckling, and support from family and health care providers. Support from the woman's partner is also important (Gribble 2003). Szucs et al. (2009) report the first published case of premature twins whose adoptive mother induced lactation. Both infants received human milk (adoptive mother's milk) exclusively at 2 months of age. This information is encouraging in the light of the difficulties that mothers' of preterm infants face when they find their milk supply is waning.

2.2.6 Conclusion

Supporting mothers in providing milk for their VLBW infants is an important goal for NICUs because mothers who are unable to interact with their babies during the post partum period, and for extended periods of time afterwards, face a particular challenge when it comes to establishing and maintaining a supply of breast milk for their infants. Mothers may be dependent on milk expression for many weeks or months until their infant is able to breastfeed effectively. Studies have shown that as a result of these difficulties, breast pumping and/or breastfeeding tends to decrease after the first 2 weeks. Pineda (2011b) found that although 78% of all mothers initiate pumping, less than half continued to pump after 2 weeks. Whilst all mothers are at risk of stopping milk expression there are a number of primary mediators (intended length to breastfeed, maternal education, income, and infant gestation) as well as secondary mediators (early frequency of breast stimulation, early milk output, and supplementation with artificial milks) that may influence milk output in mothers of preterm and term infants the first 6 weeks postpartum (Hill et al. 2005a; Lessen and Crivelli-Kovach 2006). It is important, therefore, that mothers understand the benefits of breastfeeding and the process of milk production and are given all available support to maximise their chance of success. In order to do this, staff must have the skills and knowledge to support, guide and counsel mothers in their decision to breastfeed and assist them to safely and effectively pump, collect and store breast milk. This section has

highlighted the areas of knowledge that clinicians need to master, in order to identify and support those mothers who are at increased risk of delay. The following section will review the research that has been undertaken to explore the effectiveness of training interventions to improve clinician knowledge to support breastfeeding management in NICU.

Section 3 - Review of Educational interventions for clinicians to improve breastfeeding outcomes in NICU

2.3.1 Introduction

Neonatal clinicians are in a prime position to provide valuable breastfeeding education and advice to mothers of sick or preterm newborn babies, and their skilled support can have a positive effect on women's initiation, duration and experiences of breastfeeding (Siddell et al. 2003; Lessen and Crivelli-Kovach 2006; Pineda et al. 2009). WHO recommends that all health professionals who assist women with breastfeeding have at least 18 hours training in breastfeeding (UNICEF, 2006), and education has been identified as key to implementing the BFI programme in NICUs (Taylor et al. 2011). However, the necessary skills and knowledge that clinicians require to support breastfeeding practices may have been neither part of their basic professional education nor of their NICU training (Renfrew et al. 2006). Further, faulty nursing practice, knowledge deficits and negative attitudes may impede successful breastfeeding on NICU (Nyqvist 2013). The literature suggests that education of neonatal staff can mediate some of these effects and the aim of this review is to analyse the impact of educational interventions on neonatal clinicians' knowledge and confidence to support breastfeeding practice on NICU (Renfrew et al. 2009).

Mothers of preterm infants face unique breastfeeding challenges and often experience a sub-optimal milk supply caused by early delivery or a delay in the onset of lactogenesis II. There have been a number of studies that explore the experience of mothers who breastfeed their babies on NICU. A UK survey of over 500 mothers described a lack of support and conflicting advice from staff, with 5% of mothers' reporting feeling pressurised to move onto bottle feeds (Edmunds and Nevill 2008). Other studies have reported inconsistent advice (Jaeger et al. 1997; Flacking et al. 2006), or lack of expert advice (Nyqvist et al. 1994; Jaeger et al. 1997; Jones et al. 2004; Nyqvist 2013). In their systematic review of five qualitative and two mixed methods studies published between 1994 and 2011, looking at parents' views on factors that help or hinder breast milk supply in NICU, Alves et al. (2013) identify the

importance of providing accurate information regarding breast milk supply strategies and positive, consistent and continuous reinforcement and feedback to stimulate mother's motivation. Maternal breastfeeding self-efficacy has been identified as an important variable affecting breastfeeding outcomes in mothers of preterm infants (Swanson et al. 2012; Wheeler and Dennis 2013). Staff play a vital role in ensuring the environment is favorable to enhancing maternal self confidence (Flacking et al. 2006; Boucher et al. 2011) and can influence the decision to initiate and continue breastfeeding (Nyqvist et al. 1994; Swanson and Power 2005).

In order for staff to facilitate maternal self-efficacy they must have confidence in their own specialised knowledge and ability to convey correct information to mothers. Yet poor knowledge about breastfeeding and low levels of confidence and clinical competence has been reported in US and UK literature (Renfrew 2006; Strong 2013). Clinician attitudes towards breastfeeding may also negatively affect their practice through lack of experience, education, or encouragement. Research using interviews with student nurses in the USA Cricco-Lizza (2006) describe how the role of personal experience impacts on the development of breastfeeding attitudes as students generally believed that breast-feeding offered benefits for babies and mothers, but the beliefs were stronger for those who grew up with breast-feeding as the norm. This study also reported that most felt ambivalent about whether breastfeeding promotion would be forcing their personal views upon mothers. In a later study, NICU nurses describe how breastfeeding among their families and friends is often associated with difficulties, suggesting that past experience and education about evidence based practice must be addressed to bring about the promotion of breastfeeding (Cricco-Lizza 2009a). It is also important to note that positive breastfeeding attitudes are not always correlated with personal breastfeeding experience (Siddell et al. 2003); however high levels of clinician knowledge is predictive of informational, technical, and emotional supportive behaviour towards breastfeeding mothers (Bernaix 2000b).

Whilst nurses have the most constant contact with the mother during the infants' period of hospitalisation it is also important to address the educational needs of the wider multidisciplinary team in order to maintain the consistency of advice and support given. Two American surveys that were conducted at 10 year intervals to measure paediatricians' knowledge, attitudes and practices to support breastfeeding found that from 1995 to 2004 the numbers of those who reported receiving education about the management of breastfeeding had increased from 57.9% (n = 1081) to 67.6% (n = 852) (Feldman-Winter et al. 2008). However, despite the fact that more paediatricians had received training, fewer thought the benefits of breastfeeding outweighed any difficulties or inconvenience, and more paediatricians recommended that mothers of full-term infants not breastfeed or discontinue breastfeeding for unnecessary reasons. Importantly, the quality of the training and improvements in knowledge were not evaluated. The authors speculate that the decline in attitudes may therefore reflect poor knowledge about how to overcome barriers and challenges to breastfeeding.

A web-based survey of paediatric program directors in the USA (n=132) regarding breastfeeding education and support services for residents reported limited training in breastfeeding management in clinical settings (Osband et al. 2011). This echoes the findings of an earlier UK study that found only half the paediatricians (out of a total n=120) who took part in a national survey felt competent or expert in clinical breastfeeding skills and about a third felt competent or expert in the educative skills to support breastfeeding (Wallace and Kosmala-Anderson 2006b). Further international studies have also identified the lack of skills and knowledge of medical staff and postgraduate trainees (Brodribb et al. 2008; Leavitt et al. 2009). Therefore, in order to optimise breastfeeding practices, high quality breastfeeding education should be part of ongoing continuing medical education in order to ensure the medical community play their role in promoting, protecting and supporting optimal health outcomes in this vulnerable population.

There is evidence that comprehensive education may result in increased knowledge, more positive attitudes, and improved practice in maternal and child health services (Hillenbrand and Larsen 2002; O'Connor et al. 2011; Ward and Byrne 2011). However, whilst many studies show the benefits of education and training to support breastfeeding, they often focus on the feeding outcomes rather than staff knowledge and confidence (Shinwell et al. 2006; Ekström et al. 2012; Kutlu et al. 2007; Grossman et al. 2009). This study has chosen to focus its outcome on knowledge outcomes in order to both establish learning needs and focus on creating a climate in which the learner is actively engaged in the process of constructing knowledge. Perhaps because it is a relatively specialised area of nursing care, few intervention studies have focused on the specialty of neonatal intensive care, despite the very different challenges that mothers of preterm and sick babies face when choosing to breastfeed their infant. The purpose of this literature review is to highlight those studies that will be used to inform the development of the educational intervention to be tested in this programme of research.

2.3.2 Methods of review

Review Question

Are interventions for neonatal clinicians to support breastfeeding in NICU effective in improving their knowledge?

Participants:

Health professionals working in NICU

Interventions

Any intervention or combination of interventions that addressed knowledge of breast milk expression, breastfeeding or breastfeeding in NICU (to include storage of breast milk.)

Outcomes

Primary outcomes:

Clinician knowledge assessed qualitatively or by subjective ratings.

Secondary outcomes:

Measures of breastfeeding or breastfeeding

Search Methods:

Structured searches were conducted on 9 electronic databases in June 2014 and were undertaken by the specialist librarian at UHCW. The search strategy for this review included searches through medical and nursing databases including CINAHL, British Nursing Index, ProQuest Hospital Collection, CINAHL, Cochrane, PubMed, BNI, TRIP, BestBETs for both quantitative and qualitative research papers on educational interventions for clinicians to support breastfeeding in NICU. Other forms of literature search included looking for research by forward and backward chaining was undertaken once full text articles were obtained.

Search terms:

The keyword search terms included: breastfeeding, milk, human or breast milk, Baby-Friendly Hospital Initiative, breastfeeding, breast milk storage, human milk storage, staff knowledge, student knowledge, nursing knowledge, professional knowledge, healthcare personnel knowledge, health-care provider knowledge, lactation, self-efficacy, staff confidence, healthcare personnel confidence, healthcare provider knowledge, healthcare provider confidence, preterm, preterm infant, neonatal, intensive care, neonatal intensive care vulnerable infants and NICU.

Eligibility Criteria

Types of study: Randomised controlled trials, non-randomised controlled trials with concurrent controls and before-and-after studies (cohort or cross-sectional), in English in

developed or developing countries were included. The publication date is during the period 1994 to 2014 in order to reflect contemporaneous issues in NICU.

Types of participant: Participants to include health care professionals working in NICU including doctors, advanced neonatal nurse practitioners, neonatal nurses, nursery nurses and student nurses.

Types of outcome measure: All educational interventions relating to breastfeeding management and support that measured knowledge either post intervention or pre and post intervention.

Exclusion Criteria

Publication type: non-peer reviewed articles (e.g. letters) or conference literature that were reports of training interventions were excluded.

Intervention type: research papers that did not include clinician knowledge outcomes of educational interventions in NICU.

Outcome measures: Breastfeeding rates, maternal satisfaction with breastfeeding support or any quality improvement measures not related to knowledge outcomes.

2.3.3 Results

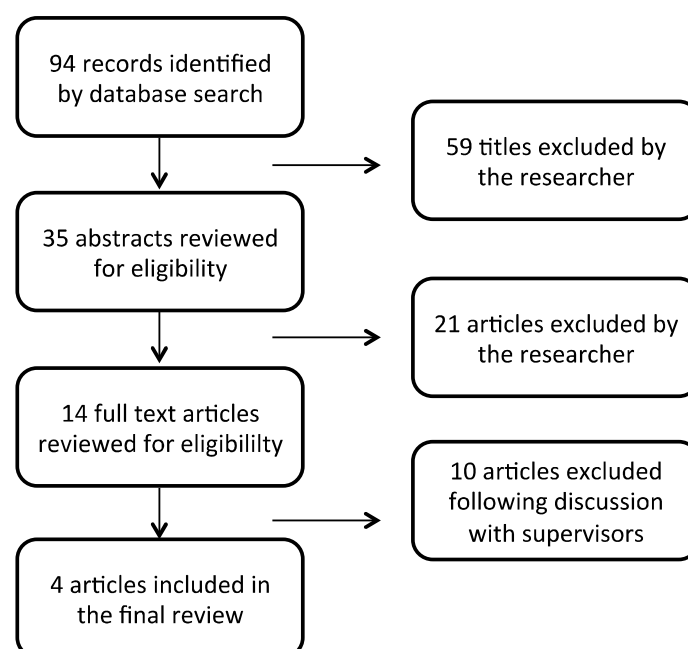
Study Selection

In total 94 records were identified by the database search; Appendix 2 details the search strategies used. The researcher scanned the titles of the identified studies and fifty-nine were excluded for not meeting the inclusion criteria of a NICU setting. The abstracts for 35 were then reviewed for eligibility and the researcher excluded a further 21, as they did not meet the inclusion criteria of educational intervention. During the next stage 14 full text articles

were reviewed and discussed with two supervisors. Eight studies were excluded because they were quality improvement measures that did not include clinician knowledge outcomes of educational interventions in NICU. Two were excluded because the study was not undertaken in a NICU environment. Four articles were finally identified that met all the inclusion criteria (Figure 3). The quality of eligible studies was assessed using Critical Appraisal Skills Programme tool (CASP) (Singh 2013).

Three of the studies (Siddell et al. 2003; Jones et al. 2004; Bernaix et al. 2008) were before and after intervention studies that included the education of NICU health professionals. The fourth study (Pineda et al. 2009) was a post educational intervention evaluation alone. All interventions aimed to increase knowledge and change professional practice to support breastmilk feeding. All were research articles; three studies were conducted in the USA and one in the UK. Three of the designs followed a knowledge pre-test, post-test format and of these one study uses a control group of paediatric nurses who have no training intervention. Feeding outcomes are measured in two of the studies and only one of these employs a controlled cohort group to compare infant outcomes. Mothers perceived lactation support is measured in one study.

Figure 3. Search strategy flow diagram



Articles excluded from this review were research papers that did not include clinician knowledge outcomes of educational interventions in NICU. Literature reviews and systematic reviews were used as a literature source but were excluded from the review itself.

Study Characteristics

Methods

All of the studies measured knowledge following a breastfeeding educational intervention in NICU; three used a pre-test/post-test design; one study used a post-test only design (Table 1). Bernaix et al. (2008) performed a time series analysis of scores to include immediately post intervention and 2 weeks and 3 months post intervention. One study, (Siddell et al. 2003), used an untreated control group for comparison. Jones et al. (2003) conducted a clinical audit of baby's notes alongside the intervention to provide background information regarding patient care and feeding outcomes, whilst (Pineda et al. 2009) conducted a retrospective audit of breastfeeding rates. All were single centre studies and conducted in a hospital setting and were published in English between 2003 – 2009.

Participants

From the four studies there were a total of 238 participants. The majority were nurses (n=221), but also included doctors (n=5), rehab therapists (n=3), social workers (n=2), respiratory therapist (n=1), nurse practitioner (n=1) and 'other health professionals' (n=5). (Siddell et al. 2003) used an untreated control group that consisted of paediatric nurses (PEDI). Demographic characteristics of nurses were presented in two of the articles (Siddell et al. 2003; Bernaix et al. 2008) and only two of the studies included the multidisciplinary team (Jones et al. 2004; Pineda et al. 2009). Three of the four studies were conducted in the US; the fourth was conducted in the UK (Jones et al. 2004). Recruitment methods were similar across studies; clinicians working on the NICU were invited to take part in an in-house breastfeeding education programme (Table 2).

Table 1. Included Studies: Design, Participants, Setting, Method and Interventions					
Author, year and country	Design	Participants	Setting	Method	Educational Intervention
Siddell et al. (2003), USA	Pre-test/post-test with an untreated staff control group	Total pre and post test n= 51 Nurses 30 NICU 21 Paediatric	Freestanding children's hospital in Northeast United States. Level III NICU (26 beds) and 3 pediatric medical/surgical units (66 staffed beds)	Knowledge and attitude Questionnaire: 2 weeks pre and 2 weeks post intervention.	An 8 hour breastfeeding education program specifically designed for NICU nurses, practical teaching sessions and panel discussion with 4 mothers who had breastfed on NICU
Jones et al. (2004), UK	Pre-test/Post-test. Pre/post intervention audit of Infant cohorts (not matched)	N=34 staff 8 NICU trained midwives, 8 NICU trained paediatric nurses, 2 paediatric house officers and 1 paediatric registrar pre-intervention cohort babies n=90 post-intervention cohort babies n=76	NICU North Staffordshire UK Maternity hospital between Sept 2001 and Feb 2002	Knowledge test pre and post intervention Audit of notes pre and post intervention 1 year apart to measure breastfeeding outcomes.	Training programme in 5 modules/10 hours delivered by a neonatal breastfeeding co-ordinator - allocated away from clinical area. The programme included practical assessments and tutorials.
Bernaix et al. (2008), USA	Quasi-experimental, time series pre-test/post-test	64 NICU nurses pre test, 32 post test 2 sets of mothers n=19 and 13	Midwestern USA 42 bed NICU in tertiary care children's hospital 40 admissions a month 120 nurses	Nurses' knowledge, attitudes and beliefs measured: 2 weeks pre, immediately post, 2 weeks post and 3 months post Mothers' perceived support measured pre and 3 months post intervention	4 hour educational intervention using lecture and discussion format taught by neonatal nurse practitioner/lactation consultant

Table 1. Included Studies: Design, Participants, Setting, Method and Interventions					
Author, year and country	Design	Participants	Setting	Method	Educational Intervention
Pineda et al. (2009), USA	Knowledge post-test Pre/post intervention matching cohort infants with control group. Retrospective audit of breastfeeding outcomes	89 HCPs (63% of all HCPs working in the NICU) 75 nurses, 3 rehab therapists, 1 nurse practitioner, 2 neonatologists, 2 social workers, 1 respiratory therapist, 5 other health professionals 81 infants pre-intervention 54 infant-mother dyads post- intervention group.	NICU USA Between April 2004 and April 2005	Staff Knowledge test: post-test over 6 week period. Breastfeeding outcomes measured.	One hour educational presentation or self study educational module delivered

Table 2. Included Studies: Outcomes, Measurement, Results, Inclusion/Exclusion and Limitations

Author, year and country	Outcomes	Measurement	Results	Inclusion/Exclusion	Limitations
Siddell et al. (2003), USA	1. Relationship between nurses' demographic variables, knowledge and attitudes pre intervention 2. Nurses' knowledge and attitudes about breastfeeding post intervention	Demographic 5 items, knowledge 7 items, Pro-breastfeeding 4 items, baby-focused care 5 items, nurse-focused care 3 items.	A significant increase ($F= 21.43$, $p<.001$, $df=1,49$) in NICU nurses' knowledge post intervention. Higher education was a significant predictor of higher knowledge scores.	Registered Nurses (RNs) working at the children's hospital. The intervention group (NICU) consisted of RNs, regular staff, and per diem nurses, who work in the hospital's NICU. The comparison control group (PEDI) consisted of pediatric staff RNs who work on the medical/surgical units.	Internal consistency of measure marginal. Non-equivalent control group (NICU versus PEDI), small sample size and attrition. Intervention conducted at single site with single set of instructors - to what degree can the effects be attributed to instructor expertise?
Jones et al. (2004), UK	1. Clinician knowledge difference pre and post intervention 2. a. Fed expressed breast milk b. Documented problem solving plans in notes c. KMC offered d. Incidence of baby being put to the breast e. Breast feeding on discharge	1. Knowledge test 2. Clinical audit	1. Overall improvement $p<0.001$ 2. a. pre 86% post 97% $p=0.012$ b. pre 2% post 86% $p<0.0001$ c. pre 65% post 85% $p=0.006$ d. pre 75% post 94% $p=0.002$ e. pre 67% post 79% $p=0.10$	Only babies who were breastfed were included in the study	Audit included infants that had only briefly been in the unit. Staff had little opportunity to have influence. Audit questions not applicable to bottle fed babies thus limiting data that could demonstrate an improvement in those who had not expressed a wish to breastfeed.
Bernaix et al. (2008), USA	1. Relationships between demographic variables, knowledge and attitudes 2. Lactation knowledge, attitudes, and beliefs pre and post intervention	1. 13 item demographic questionnaire 2. 24 item Nurse Lactation Survey 3. 64 item Nursing Support for Breastfeeding Questionnaire	1. Intentions to provide lactation support were positively correlated with nurses' age, years of experience working in the NICU, subjective	None stated	Small convenience sample limits generalisability, also related to this is that nurses predominantly represented one ethnic background (White) and one setting.

Table 2. Included Studies: Outcomes, Measurement, Results, Inclusion/Exclusion and Limitations

Author, year and country	Outcomes	Measurement	Results	Inclusion/Exclusion	Limitations
	3. Intention to provide lactation support to mothers post intervention 4. Mothers' perceptions of support pre and post implementation of intervention	modified for NICU 4. 46 item Mothers' Perceived Support Questionnaire and 12 item demographic questionnaire	normative beliefs, and lactation beliefs. Beliefs about lactation improved with knowledge 2. Knowledge scores significantly improved at each intervention time point compared to pre test score except at 3 months 3. Move from moderately positive to very positive 4. Post intervention sample perceived statistically greater support (p=0.019)		Self-selection bias (nurses already highly motivated and knowledgeable?)
Pineda et al. (2009), USA	1. Breast milk feeding initiation pre and post intervention 1. Breastfeeding at the breast pre and post intervention 3. Breast milk feeding at discharge pre and post intervention 4. Clinician knowledge post intervention	1-3 Retrospective chart review: 4. 20-question post-test	1. 74.1% to 85.2% - not significant. 2. 25.9% to 44.4% p<0.03 3. 35.8% to 40.7% - not significant 4. 100% scored > 80% = pass	Very low birth weight (VLBW) infants hospitalized in the NICU for more than seven days and born weighing <1,500 g.	Necessary infant feeding sample size post intervention was not obtained. Poor representation of neonatologists in final sample

Interventions

The four studies were variable in relation to the style, duration and complexity of the interventions (see Table 1 above). The content of the intervention was outlined in all studies and included breast anatomy and lactation physiology and breast milk expression in the context of the high-risk infant. In all studies, neonatal breastfeeding coordinators or lactation specialists delivered the intervention using either a lecture or tutorial format. One study had the alternative option of a self-study module (Pineda et al. 2009). Course duration ranged from 1 hour (Pineda et al. 2009) to 10 hours (Jones et al. 2004), the latter course divided into 5 sessions. Two studies included practical elements using dolls and breast models and nipple shields (Jones et al. 2004; Siddell et al. 2003), and one included a panel discussion with 4 mothers who had attempted to breastfeed their infants on NICU, and provided written resource materials (Siddell et al. 2003). Jones et al. (2004) developed an educational intervention that was designed using research-based evidence regarding preterm mammary physiology, breast milk expression and the establishment of preterm oral skills. They also provided a CD-ROM about human lactation if personal tuition was required and videos were available if additional guidance was required.

Pineda et al. (2009) evaluated the effectiveness of a three part educational intervention instituted concurrently over a 6-week period, which included staff training, complementary educational pamphlet for mothers, and the addition of a breastfeeding pathway to the baby's care plan. The educational pamphlet was developed to ensure that all mothers received a standard set of educational points about breastfeeding during their infants stay and that the information was consistent with staff training materials. The care pathway was modified to ensure the documentation of specific key points to support breastfeeding. Bernaix et al. (2008) incorporated motivational encouragement for the purpose of empowering the nurses in addition to the specific breastfeeding content. A common finding amongst all study interventions was the lack of, or failure to mention, any educational theory behind the development of the interventions.

Measurement Tools

Knowledge

Each study employed a unique method to assess knowledge. (Bernaix et al. 2008) reported using the Nurse Lactation Survey (NLS), a 24-item questionnaire with a forced-choice (true/false/unsure). The highest possible score is 24, and reliability is reported as Cronbach's alpha of 0.52 (pre-intervention) and 0.55 (3-month post-intervention), and a Guttman Split-Half coefficient of 0.57. The 2-week test-retest reliability correlation for the NLS was 0.33, ($p=0.162$). Pineda et al. (2009) used a 20-question multiple choice post-test and created a pass mark of 80 per cent to signify adequate breastfeeding knowledge but do not report validity and reliability testing. Siddell et al. (2003) created a 7 item knowledge test (KNOW) from the content of the educational intervention, reporting Cronbach's alpha of 0.72 (pre-intervention) and 0.76 (post-intervention). Finally, Jones et al. (2004) designed eighteen short, hypothetical vignettes to test knowledge. In order to ensure reliability and validity of the questionnaire, feedback was sought from experienced specialists in relation to accuracy, relevance, construction flaws, bias and level of readability. There is no description of the method of assessment to ascertain the possible random score. Five trainee neonatal nurses undertook user testing of the training and questionnaire.

Nurse attitudes

In order to measure nurses' intentions, attitudes, and beliefs about providing lactation support to new mothers during the immediate postpartum period Bernaix et al. (2008) used the Nursing Support for Breastfeeding Questionnaire (NSBQ). The NSBQ is a modified, 64 item questionnaire that uses the Theory of Reasoned Action (TRA) (Ajzen et al. 1980) constructs in order to measure four sub scales: normative beliefs, combined beliefs, attitudes and intentions of nurses' about providing lactation support to new mothers in NICU. The tool is comprised of five subscales; responses to each of the items are based on a 7-point Likert-scale format. Internal consistency reliability for the original tool is supported by Cronbach's a coefficients ranging from 0.75 to 0.93, for the five subscales. Content validity for the modified

tool was established based on the review of literature and consensus between a certified lactation consultant and two doctorally prepared nurse researchers and the Cronbach's alphas is reported as above 0.72, except for the combined subscale of normative referents and the motivation to comply with those normative referents which had a Cronbach's α of 0.58 at the 3-month post-intervention measurement. However, Bernaix et al. (2008) state that because inconsistency in breastfeeding attitudes and values for each referent used by each nurse would be expected, internal consistency of this subscale would not be anticipated. Siddell et al. (2003) measured nurses attitudes towards breastfeeding using (1) pro-breastfeeding attitudes (Pro-BF), (2) attitudes representing baby-focused care (BFC), and (3) attitudes representing nurse-focused care (NFC). 'Baby-focused' items refer to actions directed toward the needs of the exclusive needs of baby, whilst 'nurse-focused' items refer to arranging breastfeeding support at the convenience of the nurse's work schedule, rather than the needs of the mother-infant dyad. Items for the Pro-BF, BFC, and NFC attitude measures were derived from a review of literature related to nursing attitudes.

Maternal perceptions of lactation support

Only one study used maternal perceptions of support as an outcome. Bernaix et al. (2008) used the Mothers' Perceived Support Questionnaire (MPSQ) (Bernaix, 2000), a 46-item tool measured on a 5 point Likert scale and modified from an earlier design. Items were subdivided into three groups to differentiate different types of lactation support: informational support (16 items), technical support (15 items), and emotional support (15 items). Previous internal consistency reliability of the original version of the instrument was reported as 0.97 overall, and between 0.91 and 0.95 for each of its three subscales. Overall coefficient alpha values for this study were 0.94 (pre-intervention) and 0.96 (3-month post-intervention) and between 0.79 and 0.92 for the subscales.

2.3.4 Summary of Findings

Knowledge

In the study by Siddell et al. (2003) seventy-eight questionnaires were distributed before training commenced. Fifty-one matched pre-test and post-test questionnaires were secured (NICU=30, PEDI=21) with a return rate of 62.5%. Demographic data collected to measure comparisons showed no significant differences between the 2 groups (NICU and PEDI) on demographic variables of age, nursing education, years employed in present position, or personal breastfeeding experience. Regression analysis was used to study the relationship between the demographic variables of age, nursing education, length of employment in present position, and personal experience with breastfeeding with survey scores pre-intervention. The only significant predictor of higher knowledge scores (KNOW) was higher education attained in nursing ($R^2 = 0.06$, adjusted $R^2 = 0.05$, $p < .05$). Pre/post intervention repeated measures ANOVAs were significant for KNOW ($F = 21.43$, $p < .001$, $df = 1, 49$) showing an increase in knowledge scores in NICU nurses.

In Jones et al. (2004) study thirty-four staff took part in the training intervention. Pre and immediate post intervention testing was analysed using the Wilcoxon signed rank test. Results showed that median scores improved from 32.5 pre-test to 44.6 post-test from a possible total of 85. The median range showed a wide range of knowledge, 9-39 pre-test and 34-60.5 post-test with a statistically significant overall improvement ($p < 0.001$). They do not report on the use of the CD-ROM about human lactation or whether users required personal tuition or videos. A total of 88 clinicians participated in the educational initiative run by (Pineda et al. 2009) including 77% of the nursing work force ($n=75$) and 2 neonatologists. A score of 80% was considered to suggest adequate knowledge acquisition about breastfeeding in NICU and scores were dichotomised to pass or fail. All participants who took part in the educational initiative achieved a pass. Bernaix et al. (2008) measured differences in sample characteristics of age, ethnicity, education, employment status, breastfeeding training,

whether they participants were themselves parents and their personal breastfeeding experience between the pre-test (n=64) and post-test (n=32) group of nurses, and noted none were statistically significant. Lactation knowledge scores improved at each post intervention time point when compared with the pre-intervention measurement. A bivariate analysis for the effect of time on knowledge scores revealed statistically significant results for Time 1 (pre-intervention) to Time 2 (immediate post-intervention) ($p<.000$), Time 1 to Time 3 (2 weeks post-intervention) ($p<.000$), and Time 2 to Time 4 (3 months post-intervention) ($p<.000$). Although knowledge scores increased Time 1 to Time 4, the difference was not statistically significant.

Breastfeeding outcomes

Pineda et al. (2009) measured pre and post intervention feeding outcomes from matching cohort controls of babies. The inclusion criteria being: $<1.5\text{kg}$ and seven days old or more, and who were free of disease/disability that would contraindicate breastfeeding or oral feeding. Data was collected from the same time of year to account for seasonal confounds. T tests and Chi-squared tests were used to investigate differences in maternal age, socioeconomic status, marital status, and infant birth weight, gestational age, race, number of siblings, and length of stay between groups. Differences across groups were evaluated using Mann-Whitney U for continuous variables and Chi-squared for dichotomous variables. There were no significant demographic differences between the pre-intervention (n=81) and post-intervention (n=54) groups. Because multiple comparisons were made, the significance levels of the individual tests underwent Bonferroni adjustment. The results for breast milk feeding initiation showed a statistically insignificant increase from 74.1% to 85.2%. Breastfeeding rates increased significantly from an average of one time for every 17 days of admission to one time for every 7 days of admission (Mann-Whitney U $p<.01$). The odds ratio of 'ever breastfed in hospital' was also calculated to be 2.3 with a 95% confidence interval of 1.1-4.8, indicating that women in the post-intervention groups were more than twice as likely to breastfeed their infants while in the hospital. Breastfeeding at discharge increased from 35.8% to 40.7% but this was not statistically significant. Jones et al. (2004) report an

improvement following the intervention in kangaroo care ($p < 0.0001$), cup feeding ($p = 0.006$), receiving breast milk ($p = 0.012$) and the numbers of babies put to the breast ($p = 0.002$). Data showed that the proportions of babies discharged exclusively breastfeeding was 67% initially and 79% post intervention but this was not statistically significant. Chi-squared test was applied to the audit results but this paper only reports on the p value.

Nurse attitudes

Two studies looked at the impact that demographic variables and the educational intervention had on nurses' attitudes towards breastfeeding in NICU. Siddell et al. (2003) compared the demographic variables between the 2 groups (NICU, PEDI) and found no significant differences on age, nursing education, years employed in present position, or personal breastfeeding experience. 'Satisfaction with breastfeeding experience' was not explored for group differences in the regression analyses due to low response rate on that variable ($n = 16$). Regression analysis studying the relationship between the demographic variables of age, education (highest degree in nursing), length of time employed in present position, and personal breastfeeding experience (history of satisfaction with breastfeeding experience) found that length of employment in present position, age and education level were significant predictors of Pro-BF attitudes ($R^2 = 0.14$, adjusted $R^2 = 0.09$, $p < .01$), though length of employment showed a negative relationship. Further regression analysis found the significant predictors of BFC to be length of employment, personal breastfeeding experience, and education ($R^2 = 0.11$, adjusted $R^2 = 0.05$, $p < .01$). Breastfeeding experience and education were positively related, whilst length of employment was negatively related to BFC attitude. No significant predictors were found for NFC. The only significant predictor of higher KNOW scores was higher education in nursing ($R = 0.06$, adjusted $R = 0.05$, $p < .05$). The post intervention mean scores showed a significant positive change in all variables in the intervention group except Pro BF score.

In the study by Bernaix et al. (2008) nurses completed a 13 item demographic questionnaire, which measured selected demographic data including highest nursing degree, recent attendance (within 2 years) to continuing education courses specific to lactation and the nurse's personal breastfeeding history. Of the group of nurses assessed pre-intervention, the majority (75%, $n=48$) had never attended any continuing education courses specific to breastfeeding despite the mean time of experience as a NICU nurse being 7 years. Pearson's Product correlations performed on pre-intervention data revealed that nurses' intentions to provide lactation support were positively correlated with nurses' age ($r = 0.51, p < 0.01$), years of experience working in the NICU ($r = 0.54, p < 0.01$), subjective normative beliefs ($r = 0.32, p < 0.05$), and lactation beliefs ($r = 0.40, p < 0.01$). Beliefs about lactation, namely the importance of providing mothers' milk for the vulnerable infant and the nurses' influence on that outcome was positively correlated with the nurses' subjective normative beliefs ($r = 0.39, p < 0.01$) and pre-intervention lactation knowledge ($r = 0.32, p < 0.05$). However, nurses' attitudes about providing lactation support were negatively correlated to lactation beliefs and subjective normative beliefs ($r = -.42, p < 0.01$ and $r = -.32, p < 0.05$, respectively). Whilst nurses' intentions about providing lactation support were positive, nurses had negative beliefs about their effect on lactation outcome for mothers in their care, and did not perceive support for their attitudes/actions from their normative referents (nurse peers and administrators). Analysis of the NSBQ measure pre to 3-month post intervention was conducted using paired t-tests: that revealed all subscale scores improved significantly with measurements moving from moderately positive to very positive on intention to provide lactation support for mothers.

Maternal perceptions of lactation support

Only one study focused on maternal perceptions of lactation support. (Bernaix et al. 2008) recruited two separate samples of mothers (pre-intervention $n=19$ and post intervention $n=13$) in order to provide a cross-sectional sense of the NICU's "supportive atmosphere for lactation". Chi-squared tests for categorical data and t tests for continuous variables did not reveal any statistically significant differences between the mothers' characteristics by data

collection point. The mothers completed a 13 item demographic questionnaire for age, marital status, ethnicity, educational background, prior experience with breastfeeding and with having a child hospitalized in the NICU, their preferred infant feeding method before delivery of their infant, attendance to childbirth classes, infant age in hours since birth upon admission to the NICU, and the length in time (hours) following the delivery when the mother began to pump her breasts. They also completed the Mothers' Perceived Support Questionnaire (MPSQ) (Bernaix 2000b), a 46-item survey that uses a Likert scale to measure perceived lactation support which had been modified in this study by the author in order to capture the specific experience of a mother's experience of NICU. The second cohort of mothers repeated both these questionnaires 3 months post-intervention.

The first cohort of mothers' pre-intervention scores for the MPSQ ranged from 122 to 159 (possible score range was 46-230), with a mean of 143 and standard deviation of 9.7. When repeated by a second cohort of mothers, three months post-intervention, MPSQ scores ranged from 100 to 204, with a mean of 162 and standard deviation of 31.8. The difference in MPSQ mean scores showed a statistically significant improvement in scores ($t = 2.48$, $p = 0.02$).

2.3.5 Discussion

Knowledge

All of the studies in this review showed an improvement in knowledge following a training intervention (Table 2). Post intervention knowledge was repeatedly measured by Bernaix et al. (2008) but showed no significant improvement over pre-test scores at the longest time period point of 3 months. This may suggest that nurses may require an intervention booster no later than 3 months post intervention in order to retain the facts. Only one study did not measure knowledge prior to the intervention but used a quasi-experimental design to compare the intervention group with an unmatched control group to demonstrate improved learning outcomes between groups (Bernaix et al. 2008). However, both the lack of control

groups and the use of an unmatched control group can be seen as design limitations. None of the studies report a power calculation to estimate the required sample size to power the study. Sample sizes differed widely, with three studies having relatively small sample sizes that could affect the generalisability of findings (Table 1.) In all studies the measurement tool used to assess knowledge was unique and measures to ensure validity and reliability were either unreported or showed borderline acceptability. Bernaix et al. (2008) used the NLS, a previously untested measurement tool, to measure knowledge, and reported psychometric properties to be less than acceptable. Siddell et al., (2003) used a test that only had 7 items and used forced questions, resulting in a 50:50 chance of guessing the correct answer.

In order to establish validity and reliability Jones et al. (2004) piloted their questionnaire on five trainee neonatal nurses and sought advice from experts in relation to accuracy, relevance, construction flaws, bias and level of readability. They acknowledge that the validity of repeating pre and post-test questions can be called into question on the basis that candidates have been forewarned on the repeat test. Whilst Jones et al. (2004) argue that this can be seen as part of the learning process, and it is encouraging for candidates to see that they have progressed, exposure to correct answers is a confounding factor that is a limitation in all these studies. They also provided a CD-ROM about human lactation and offered personal tuition and videos for additional guidance but do not state if this was ever required. Jones et al. (2004) report 60.5 as the highest test score out of a possible 85 which may suggest that the learning intervention may not provide adequate information to answer the questions. Pineda et al. (2009) do not describe how they ensured validity and reliability of the knowledge test though they provide the questionnaire in full in the appendix. They also report 100% of clinicians scoring a pass mark of >80% following the intervention, a lack of variability that may reflect an inadequate measurement tool.

Bernaix et al. (2008) and Siddell et al. (2003) measured the effect of personal employment related data and training and experience on staff knowledge. A main outcome of Siddell et al. (2003) is that those nurses who had attained a higher level of nursing education were more

knowledgeable about breastfeeding. In their description of the limitations of their study (Bernaix et al. 2008) acknowledge that a self selected group of nurses (64 out of a possible 120, of whom only 32 complete the post-test) undertook the training and they may be unrepresentative of the workforce as they were more motivated to take part. They go on to report that older and more clinically experienced nurses were more knowledgeable about breastfeeding and had greater intentions to provide breastfeeding assistance to mothers. However it is worth noting in this study that for a majority of the nurses in the pre-intervention group (75%) this was an introduction to breastfeeding training.

Two of the four studies include the multidisciplinary team in their training (Pineda et al. 2009 and Jones et al. 2004); however neither of these studies includes demographic information in order to explore the different learning needs and outcomes across different groups. Jones et al. (2004) included a practical aspect to the training intervention but the authors do not clearly define what this was or how it was implemented. No formal practical assessment tool is described and the outcome of the assessment is not discussed. A further limitation of all the studies is that none provide feedback regarding participant experience of using the learning intervention. This could have been explored through qualitative interviews and could have been used to explore knowledge acquisition and motivation to apply knowledge.

Nurse attitudes

Two of the studies in this review measured staff attitudes as well as knowledge, in order to explore wider factors that may influence clinical practice. The importance of clinician knowledge and attitudes towards breastfeeding was highlighted in an earlier study by (Bernaix 2000b), who found nurses' supportive behavior was best predicted by their breastfeeding knowledge and attitudes rather than intentions in a non-NICU setting. In this later study Bernaix et al. (2008), report that age, years of experience on NICU, lactation beliefs and subjective normative beliefs correlated with intention to provide support to mothers, although knowledge did not. However, knowledge, along with nurses' subjective normative beliefs, correlated with nurses' beliefs about lactation. Importantly, the study

showed that despite nurses' having positive attitudes towards providing lactation support, they felt negative about their ability to impact on the lactation outcomes for mothers, and did not feel supported by their peers and managers. However, for a majority of the nurses this was an introduction to breastfeeding training, and therefore their lack of confidence in their ability to put training into practice perhaps highlights the absence of the promotion of breastfeeding practices institutionally, and may explain why training has not been a priority. The training intervention had a positive effect on attitudes and beliefs about breastfeeding as well as intentions to assist new mothers (Table 2). It also showed that the intervention had a sustained positive effect on nurses' lactation attitudes, beliefs and intentions at 3 months, unlike knowledge scores. Whilst Bernaix et al. (2008) incorporated motivational encouragement for into the training intervention they do not describe how this was designed or what it entailed.

Siddell et al. (2003) demonstrate that the training intervention enhanced attitudes about breastfeeding. However, they only examined changes in knowledge and attitudes once following the intervention (at 2 weeks) and concluded that knowledge and attitudinal change resulting from an educational intervention should be examined over time. Conversely, Siddell et al. (2003) found a negative relationship between length of time nurses had worked on NICU and pro breast feeding and baby focused care attitudes. This demonstrates the importance not making assumptions about the knowledge and attitudes of those staff considered to be more senior and more experienced and highlights the need for continued professional development once nurses are established in the workplace.

Breastfeeding outcomes

Collecting data from staff can be associated with a risk of bias in participant selection, such as interest in the subject or personal experience; therefore auditing breastfeeding data can provide further information to support evidence of change resulting from an intervention. In order to measure breastfeeding outcomes, Jones et al. (2004) audited medical and nursing records of discharged babies pre and post training intervention (1 year). Pre and post audit

groups were divided into those intending to breastfeed and those intending to bottle-feed. Findings are only reported on those intending to breastfeed, consequently the audit did not capture the effect of training on breastfeeding initiation rates. Also this limits the findings of the effectiveness of the intervention on mothers who had already decided to breastfeed, thereby precluding findings on the impact on those who did not. A further limitation of this study is that it does not include any detailed information regarding the types of babies the unit manages and does not describe the characteristics of the babies in the audit. More detailed information regarding the gestation and weight of these babies would allow a clearer interpretation of the results. The authors acknowledge that improvements seen in auditing the post intervention group may be partly as a result of better record keeping by staff, as this was noted to have improved during the study period.

It is important to collect data on infants such as birth weight and gestation, when measuring the impact of the training intervention on breastfeeding outcomes because preterm babies vary in gestation and this can impact on their breastfeeding outcomes. Importantly, Pineda et al. (2009) provide data on the babies in each cohort, whereas Jones et al. (2004) do not. Subsequently, Pineda et al. (2009) are able to describe the strongest predictors for not breastfeeding at discharge as low birth weight, and lower gestational age, a finding that can inform the development of future, targeted interventions. However, a limitation of the study is that the sample size of babies may have been too small to be powered to show a statistically significant effect. This study recruited a clinically challenging cohort of babies who weighed less than 1.5 kg at birth and who were likely to be preterm although the gestation is not described. The disparity in sizes between groups is recognised as a limitation by the authors and was as a result of lower numbers of admissions in the time period allowed for data collection. The authors reflect on the challenges mothers face when trying to provide breast milk during this difficult time and also the difficulties obtaining the necessary infant sample size when admission rates are highly variable. A unique aspect of this study is the use of complementary educational material for mothers, which is designed to support the same

outcome as the clinician education; however, the inclusion of this additional intervention confounds the independent effect of clinician education on feeding outcomes.

Pineda et al. (2009) focus their outcomes on the measurement of breastfeeding in order to highlight its importance as an outcome for sick and preterm babies. Because they look specifically at breastfeeding, as opposed to being breast milk fed, they do not evaluate the impact of the intervention on those infants who had received expressed breast milk via an alternative route e.g. nasogastric tube feeding. The design weakness of not measuring the rates of breastfeeding may have missed an important potential effect of the intervention. However, by focusing on whether preterm infants receive breast milk, rather than whether they are engaging in direct breastfeeding Pineda et al. (2009) highlight an important outcome measurement in this type of study, as their findings show no significant improvement in breastfeeding following the intervention and therefore highlight the necessity to design training interventions that may address this problem.

Siddell et al. (2003) provide figures for breastfeeding rates at discharge pre and post intervention. Although this study did not formally audit breastfeeding outputs on NICU it does report an improvement in both breast milk initiation and breastfeeding at discharge rates during the year following the intervention and the authors suggest that this may have been related to the nurses' improved knowledge.

Maternal perceptions

Uniquely, Bernaix et al. (2008) measure maternal satisfaction with lactation support and find mothers perceived greater support, in the sample assessed, following the educational intervention. However, in this study only a small numbers of mothers were recruited, (n=19 pre-intervention and n=13 post-intervention) and these were an homogenous group, not representative of a diverse population, but rather representative of the characteristics of mothers that would be likely to breastfeed (educated, previously breast fed) and had indicated that they wished to breastfeed prior to delivery. Whilst this study shows a

statistically significant improvement in mothers perception of lactation support, the post intervention MPSQ score mean was 143 with a standard deviation of 9.7 and the post intervention score was 162 with a standard deviation of 31.8. This result demonstrates a more variable range of scores in the second cohort of mothers, suggesting some mothers felt much better supported than others. This may reflect the fact that only half the staff in the unit actually underwent the training, thereby providing contrasting levels of care. The authors note that choosing mothers who had selected to breastfeed could mean that they would be more knowledgeable about the type of support they required and this therefore strengthens the findings. However, it could be argued that a more definitive way of assessing the impact on the mothers themselves could be in auditing breastfeeding throughout the baby's stay and on discharge.

2.3.6 Conclusion

Performing a review of educational interventions provides insight into what education in this area looks like and is key to supporting replication and dissemination. A key aspect of this process is the identification of the conceptual underpinnings of the problem in order to assist the researcher to understand and predict the elements of a potential solution (Herrington et al. 2007). No studies of eLearning training interventions for clinicians to support breastfeeding in NICU were identified for inclusion in this review. This indicates that this study provides an original contribution to this field of research as it provides a unique method for providing breastfeeding educational to neonatal clinicians. Whilst two of the studies looked at nursing attitudes none looked at nursing confidence in knowledge or confidence in practice, although this has been undertaken in non-NICU breastfeeding educational intervention studies (Watkins et al. 2010). This further demonstrates the unique contribution that this study makes to the field.

The small number of studies that met the inclusion criteria reflects the fact that studies of the effectiveness of breastfeeding training for health professionals in NICU are quite rare.

However, this review demonstrates how breastfeeding education may vary in scope, amount, educational model and assessment strategy. In each of the studies, the design of the training intervention is described as being based on current evidence-based practice, but none of the studies refer to educational theory models used. Spiby et al. (2009) review educational and evidence-based practice interventions for health professionals to support breastfeeding and identify a concerning lack of reference to general educational models. Through describing the educational theories used to inform the design of interventions it is then possible to develop an understanding of the way in which people learn. This information can then be used in to then plan the most effective ways to inform the development of future training interventions (Taylor and Hamdy 2013) and is the justification for using educational theory in this study.

The use of practical aids and a panel discussion with mothers was included in one study (Siddell et al. 2003) and Jones et al. (2004) referred to a practical assessment but the format and outcomes of this were not reported. Half of the studies offered training to the multidisciplinary team; however, none of the studies provide feedback from participants regarding their views on either the educational intervention or the assessment tool. This would have been of particular interest in the study by Pineda et al. (2009) as they provide two options for training. Education design research recommends that studies should involve multiple iterations that are user tested in in order to refine and improve training material (Herrington et al., 2007). Therefore user involvement is central to this process.

Pineda et al. (2009) describe a breastfeeding education initiative that included training as part of a wider intervention to promote breastfeeding on NICU. In a systematic review of breastfeeding promotion in NICU (Renfrew et al. 2009b) multi-faceted interventions, particularly those that include staff training were noted by to be more likely to be effective in promoting breastfeeding on NICUs than sole interventions. Several studies have been conducted to evaluate quality improvement measures to improve breastfeeding in NICU that include staff education as part of a package and have had positive results when measuring breastfeeding outcomes (Dall'Oglio et al. 2007; Burke et al. 2011; Lee et al. 2012; Gianni et al. 2014; Ward et al. 2012). However, it is often not possible to measure the educational

aspect of these studies because the training they used was part of a wider intervention, and staff knowledge was not measured. In order to ensure that education is effective, studies that explore staff knowledge acquisition pre-post training are needed, along with those that describe the design and development of the educational intervention. Essential knowledge about usability is also a key aspect in the development of eLearning interventions and should also be included in the dissemination of these studies (Sanders 2010).

All of the studies in this review used either in-house lactation specialists or educators to deliver the training, though Pineda et al. (2009) also offered a self-study alternative. Siddell et al. (2003) note that using a single set of instructors' limits the degree to which the knowledge improvement could be attributed to curriculum rather to the instructor's expertise. However, this was not discussed in the other studies, although it may have an impact on learning outcomes. It was also not made clear whether staff were shown the correct answers following testing, which would confound the results of the post-test, whilst giving an overall score would avoid this contamination. Not all studies report a range of scores, which could also help to evaluate the effectiveness of the learning intervention. Likewise, reports of validity and reliability of measurement tools were not always presented and on occasion were reported as sub-optimal.

Importantly, it has been reported that mothers do not feel guilt from being educated about the benefits of breastfeeding but they do feel guilty about not feeling fully informed (Strong 2013). It is, therefore, of paramount importance that staff have access to up to date, evidence-based education and are given the opportunity to practise their skills in order to develop the necessary confidence and knowledge to support mothers during this crucial period of infant nutrition. Small sample sizes, lack of diversity of the study population, single site locations and a lack of demographic information on both the infants and job related data for staff cohorts are all factors that limit the generalisability of these studies. Further studies should explore the long-term effectiveness of training programmes and the most effective format to deliver training. As the NICU team is a multidisciplinary workforce it is also

important to ensure that all those involved in supporting mothers are given access to the same training in order to avoid providing inconsistent or incorrect advice.

2.3.7 Chapter Summary

This chapter has explored the evidence to support the benefits of breastfeeding for infants, with a specific focus on the benefits to the hospitalised NICU infant, and the evidence base to support a learning intervention for clinicians to support breastfeeding in NICU. It has described a review of literature that has explored staff knowledge changes following educational interventions to support breastfeeding on NICU. This following chapter will discuss the process of developing the eLearning module before moving on to describe the design of this study and the iterative development and evaluation of the intervention.

Chapter 3 - eLearning Design and Pedagogy

3.1 Introduction

This study aimed to develop and evaluate online training for neonatal clinicians to enhance their knowledge and confidence in supporting mothers with breastfeeding on NICU. The educational intervention was designed for web based delivery in order that it could be integrated within the NUCAT e portal. The benefit of using this design was that it allowed clinicians to access a single site in order to complete an assessment, evaluate their training needs, undertake the training module and then repeat their assessment to see if they had achieved their learning outcomes. This chapter describes the justifications for choosing eLearning as a method to teach breastfeeding training and the processes that underpinned its design.

3.2 eLearning

Internet-based, web-based, online and eLearning are all terms that are used to describe the delivery of educational material via technology. For the purposes of this study I shall refer to the training that I have developed as eLearning, defined by the Joint Information Systems Committee (JISC) (2001) as learning facilitated and supported through the use of information and communications technology. The term 'eLearning' therefore essentially covers the use of electronic media and devices as a vehicle for knowledge exchange within teaching and learning. The online environment is becoming an increasingly popular domain in which to provide on going education, with research supporting its essential equivalence in terms of outcomes in comparison to traditional methods (Cook et al. 2008; Means et al. 2011 ; Lahti et al. 2014; WHO 2004). ELearning supporting breastfeeding practices has already been shown to be effective in the maternal/neonatal setting (O'Connor et al. 2011; Thukral et al. 2012; Weddig 2011; Velillas et al. 2007; Deloian et al. 2015; Condon et al. 2015) and offers some advantages over traditional education methods. The benefits of eLearning include the ready availability of teaching content and the ease with which it can be updated as clinical information changes, an important factor in the application of evidence based practice in all

clinical areas. ELearning also offers those that work varied schedules in the clinical environment the opportunity to access training that is readily available, rather than being reliant on attending fixed teaching sessions. Therefore, it is a practical solution to the problem of ensuring training is widely available and convenient to access for a large work force with differing availability, whilst ease of accessibility and lack of travel to attend sessions also makes it an economical alternative to class based study (Atack 2003; Dorrian and Wache 2009).

Whilst using technology to deliver course content online has been demonstrated to be an effective method of providing training, it does have limitations. Difficulties with eLearning are centred on user difficulty with technology, such as lack of formal computing skills, age, lifestyle, work, and time constraints that keep them from learning how to use technology (McVeigh 2009). In clinical nursing environments, workplace access has been identified as a problem with a lack of support for protected time for staff (McVeigh 2009; Atack 2003; Moule et al. 2010) along with inadequate or limited availability of hardware (Creedy et al. 2007) or poor Internet connections. The WHO (2015) published a systematic review of eLearning for undergraduate health professional education and cited lack of student teacher support, feelings of isolation, inability to clarify difficult concepts and lack of in depth group discussions as the main disadvantages perceived by learners. Other difficulties include those faced by academic staff tasked with the challenge of creating eLearning courses. Button et al.'s (2014) review of eLearning in nursing education highlighted the increased time and skill that is placed upon nurse educators to adapt their current teaching strategies to incorporate this method of delivery. Dariel et al. (2012) explored the underlying factors influencing eLearning adoption in nursing education and found resistance to be a justified response to the perceived pedagogical needs and experiences of the nurse educator. Therefore, all efforts must be made to ensure that the system is as user friendly as possible. Skills training, support, access to technology and dedicated work time for eLearning are required to help overcome such difficulties for both developers and users (Childs et al. 2005).

Further evidence supports the use of eLearning and describes its success in the clinical context. A systematic review Freire et al. (2015) looked at the scientific literature that supports education mediated by technology in neonatal nursing, and found very few studies had been undertaken to fit with this criteria (n=9). As a result of the low number and heterogeneity of the studies it was not possible to present a synthesis of their outcomes, however all studies reported positive outcomes and the authors call for a focus on the development and evaluation of educational resources focused on the care of newborns and their families.

3.3 eLearning design

The Department of Health acknowledges the role of technology in developing high quality, cost effective education in order to maintain the essential knowledge, skills, values and behaviours needed for safe and effective patient care. The NHS's e learning for Healthcare is a large repository for on line courses that provides training to the NHS workforce free of charge and reflects the degree of investment in this style of learning within the context of health professionals. In their publication 'A Framework for Technology Enhanced Learning' (2011) The Department of Health notes that eLearning, alongside high quality supervision, has the potential to improve confidence and competence, but identify a lack of exploited opportunities for multidisciplinary and inter-professional learning. This document outlines six key principles that focus on the role technological applications should play in the education, training and development of the health and social care workforce (Figure 4).

Figure 4. Six Key Principles to Support eLearning in the Health and Social Care Workforce
[adapted from A Framework for Technology Enhanced Learning, DH (2011)]

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Each of these six values is reflected in this eLearning module.

Ensure equity of access and quality of provision

This eLearning intervention has been designed for use by all clinicians working in NICU in order that comprehensive training is available to all professionals who come into contact with mothers who require support with breastfeeding. The equity of the training is fundamental to ensure that consistent advice and information is delivered.

Innovative and evidence-based with high quality of educational outcomes

The content is innovative and evidence-based, with a focus on equipping the workforce with the necessary skills for safe and effective patient care in order to support high quality educational outcomes. The eLearning content is relevant to a multidisciplinary workforce and was piloted on clinicians from a range of disciplines who work within NICU.

Value for money

Considerations regarding cost effectiveness should focus on the production and maintenance of high quality learning and the expected life span of the course, along with ensuring that similar content does not already exist and could be used by the intended audience. This eLearning module is both unique in its content and its design as it provides one stop access to both training and assessment. It also potentially saves on the need for an educator to deliver the content and it has the potential to be accessed at a time that suits a workforce whose shift pattern is varied, and who may find time to attend specified study days difficult. This study was funded through a PhD studentship and therefore at no cost to the service it was designed for.

Educationally coherent

The purpose of this study is to ensure that the educational content of this eLearning module is both coherent and effective. The iterative development allows for user feedback to ensure both the effectiveness of the training and the usability of the e portal.

Patient-centred and service driven

The training content is patient centred and service driven because it has been developed to address the poor uptake of breastfeeding practices in NICU, and in particular the need for staff to support mothers through providing accurate information.

Improves patient outcomes safety and experience

The eLearning intervention has been designed to improve patient outcome and safety. Whilst this study does not directly measure the breastfeeding outcomes in the local context in which the eLearning intervention is being evaluated, it is known that breast milk confers great health benefits on the infant population and feeding rates require improvement. It is the subject of a further study to evaluate this particular measure.

Whilst 'A Framework for Technology Enhanced Learning' principles underpin the ethos behind the design of eLearning, successful implementation and adoption is dependent on several factors. Guidance, relating to the practical aspects of developing eLearning, specifically within

NHS organisations, is widely available; The NHS Information Authority published guidelines in 2003 to inform the development of eLearning in the NHS. A later publication, E-learning in the Health Sector: Some Key Quality Principles (2011) identifies key domains that need to be considered for the effective design, development and deployment of an eLearning course. In 2012, 'Commissioning eLearning Resources in the NHS Key Principles and Guidance' was published for use by all those with a responsibility or role in commissioning eLearning developments for use in health service settings. A key focus of these documents is in the institutional procurement of services to support education for health care professionals and therefore not all the content was relevant to the development of this eLearning module.

Alongside these resources, further ones exist that deal specifically with eLearning design in broader education: The Learning and Skills Network provides 'A Professional Development Framework' to support eLearning development within the teaching and learning environment (LSN 2007) and The Joint Information Systems Committee (JISC) published 'Effective Practice in a Digital Age' (2009), that combines the outcomes of research with examples of current practice. However, there would appear to be no universally agreed, definitive guidelines and these guides reflect much of the information provided in Cook and Dupras (2004), who published a practical guide to developing effective, web based learning for medical education in 2004, that was based on research and personal experience. Therefore, to inform the development of this eLearning module, the advice developed by both JISC (2009) and Cook and Dupras (2004) was used in order to guide both design and pedagogic theory.

3.4 Needs Analysis

The first step in developing a web based educational intervention identified by both JISC (2009) and Cook and Dupras (2004), is to perform a needs analysis and establish the learning objectives. As stated earlier the fundamental aim of this training is to teach clinicians to support breastfeeding. However, learner's past experiences, learning styles and abilities influence their individual learning needs and identifying learning needs or lack of knowledge

can be challenging. The Johari Window is a simple model (Luft and Ingham 1955) that summarises the states of self-knowledge and is used for illustrating and improving self-awareness (Figure 5). The window is a two-by-two taxonomy of learning or development that follows the assumption that knowledge gaps need to be 'open' to both the learner and teacher in order to fully support the process of learning. Quadrant 1 is known as the area of 'free activity' and is the information known by the person and others. Quadrant 2 is known as the 'blind spot', where the learner is unable to see their own deficiencies though others can, they therefore require assistance to become aware of their learning needs. The aim is to reduce this area and thereby increase region 1 and this can be done through seeking feedback or by performing an assessment. Quadrant 3 represents what is known to ourselves but hidden from others, and again a formal assessment would be a useful tool in helping individuals to acknowledge their learning needs formally. The fourth quadrant represents information that is unknown both to the self and others and provides the potential for opportunities to discover unknown abilities without pressure to succeed (McKimm and Swanwick 2009).

Figure 5. The Johari Window

	Known to self	Unknown to self
Known to others	1 Open	2 Blind
Unknown to others	3 Hidden	4 Unknown

As mentioned above, one method of identifying learning needs is through the use of assessment tools, and educational technologies can play a role in supporting the assessment process. In this study, NUCAT formed the basis for both formative and summative

assessments, thereby both identifying the learning needs that may be 'hidden' in the blind or unknown quadrants of the Johari window and measuring learning outcomes. Advantages of e-assessment include the ability to provide instant marking and feedback and support greater tracking and transparency of results (Ellaway and Masters 2008). Benefits to the learners are that their scores are confidentially and instantly fed back to them and, as a result, they can manage their own study and performance. However, this process requires invigilation in order to secure candidate identity and security and raises the question of how to secure against cheating (Dennick et al. 2009). Because this eLearning was designed for the purpose of continued professional development, rather than for a qualification, there was no pass mark for the test and no one but the learner knew their score, therefore there was no benefit to be gained from cheating.

The results of an earlier study based at UHCW NICU, that used NUCAT to assess clinicians' breastfeeding learning needs (Wallace et al. 2013), formed the basis for the content of the training material. The development of NUCAT for this study will be described in the methodology chapter. Wallace et al. (2013) identified a lack in knowledge in the anatomy and physiology of lactation and a reduction in the self reported confidence in knowledge scores of clinicians after their assessment scores were fed back to them. This study demonstrated that an assessment such as NUCAT may help learners to identify their learning needs, and a reduction in confidence in knowledge and practice may act as an important motivator in seeking further education.

3.5 Setting learning objectives

When setting educational objectives it is important to focus on the most important knowledge that you want to convey and then strive to ensure the student's conceptual understanding of that knowledge (Magnussen 2008). Often there is an overwhelming amount of knowledge surrounding one subject and therefore it was important to isolate key information based on the latest evidence (outlined in Chapter Two). The core components of the eLearning in this

study were based around information to support a mother who is expressing breast milk on NICU. The aims and educational objectives are set out in Chapter 5 of this thesis.

3.6 Technology and resources

Cook and Dupras (2004) and JISC (2009) identify the importance of evaluating the technical resources available before embarking on the design of an eLearning module. However, Cook later makes the point that developers of eLearning may have to adopt what he describes as a paradigm of 'good enough' instruction, whereby the advantages of 'fun animation' may be outweighed by cost and not improve the level of learning (Cook and Triola 2014). This 'process v content' binary opposition is described by Ellaway and Masters (2008) as assuming a particular meaning and significance in eLearning because the designer must make decisions about whether the focus should be on digital content or the digitally mediated process. For example, if a course is predominantly about accessing materials then its focus may be on content creation and managing repositories. Whereas, courses that involve interaction with participants would require scheduling and tracking activity to become the focus.

The eLearning module developed in this study was designed as a 'stand alone' course that did not support student interaction with either the course designer or fellow students, and which ran exclusively online. The aim was for it to be accessible from any location that had internet access, and staff were encouraged to complete it at work if they had the opportunity, or if not they could complete it at home in their own time. Because students were not expected to participate in groups or activities the focus of the design was in ensuring easy accessibility and content creation and management rather than scheduling, discussion and tracking activity. Therefore, its focus was primarily about content creation, content upload/download and access (described in Chapter 5).

The Centre for Excellence in Learning Enhancement (CELE) at Coventry University provided full technical support in the development of the eLearning module. The researcher worked

closely with the technical team but had no training or skills in the technical development of the online material. Regular meetings and updates were undertaken with a lead designer from the department who was able to provide information regarding the options available in eLearning design. The role of educational content design was the responsibility of the researcher with support from a senior midwifery lecturer at Coventry University who was a subject expert in breastfeeding. The researcher identified the learning objectives and wrote the educational content for the module. The technical team at CELE gave advice and on the style and presentation of the eLearning web site and transferred all the information provided by the researcher onto the eLearning platform. The design process involved a series of meetings with the CELE technician over the two-year period in which the eLearning iterations were developed. The researcher led in the decision making process regarding the presentation of information and the images used. The researcher recorded all audio content with the technical team and was present throughout the content design stage in order to oversee progress and clarify any questions the technical team may have had. All work undertaken by the technical team could be accessed via Internet links and therefore all members of the research team were able to oversee progress and provide advice and feedback throughout the development stages.

3.7 Approaches to learning

The transition of learning from traditional face-to-face teaching to on line is described by King (1993 p. 30) as 'from sage on the stage to guide on the side', and signals a shift in the role of the teacher to that of the facilitator and requires different skills and approaches. In order to ensure effective and engaging learning content, clear pedagogic principles need to be employed in the development of eLearning content (JISC, 2009). Successful learning requires the interplay of multiple processes, including those in the cognitive, affective (i.e. motivation and emotion), social (i.e. interaction with and experience of others), environmental (i.e. location or setting) and meta-cognitive (i.e. thinking about one's thinking) domains (Young et al. 2014). Being aware of the main learning theories helps to build a consistent design,

clarifying what type of learning and interaction is intended. JISC (2009) recommend using an approach that reflects learners' preferences and abilities. However, linking learner needs, pedagogy and technology is a challenge for educators when developing eLearning (Kim & Bonk, 2006). The best way to approach this would be using a variety of learning styles.

Rather than developing eLearning for its own sake JISC (2009) support using it to extend learning potential. However, there is a paucity of good quality studies that evaluate the pedagogic methods used in eLearning and, as noted by Cook et al. (2012), theories are vague, and empiric evidence is virtually nonexistent to guide the planning of style-targeted instructional designs. In a qualitative systematic review of internet-based medical education studies by Wong et al. (2010), 17 specific pedagogic theories were named in 58 articles but all lacked sufficient reported detail to enable comprehensive testing of these theories. They therefore conclude that when designing an internet-based course, attention must be given to the fit between its technical attributes and the learners' needs and priorities, and to ways of providing meaningful interaction. Cook et al. (2010) performed a systematic review and meta-analysis of instructional design variations in internet-based learning for health professions education, and reported that interactivity, practice exercises, repetition, and feedback improve learning outcomes and that interactivity, online discussion, and audio improve user satisfaction. Cook et al. (2012) later argued that adapting education to fit learner styles is unlikely to enhance computer assisted learning, but rather efforts should focus on effective instructional methods that are carefully aligned with learning objectives. Whilst Mayes and de Freitas (2004) view technical enhancement in learning as pragmatic rather than pedagogic, being a cost effective alternative, rather than a new way to achieve deep understanding of a concept; others argue that eLearning is gradually bringing about a new theory of learning (Geraghty et al. 2013). ELearning theory remains relatively underdeveloped as a research subject and therefore further studies may be warranted to explore this question.

In their systematic review of educational and evidence-based practice interventions for health professionals to support breastfeeding, Spiby et al. (2009) identify a concerning lack of reference to general educational models. Donnelly (2010) describes the key to successful online education as the synergy that can occur between clear pedagogical and, for adults, andragogical foundations merging with effective use of technology. Healthcare professionals are 'adult learners' and when developing course content, knowledge of compatible learning and teaching styles is essential. When designing educational materials for health professionals it is important to consider that a majority of them will have already completed a university degree and perhaps even postgraduate studies (Taylor and Hamdy 2013). Each clinician will have unique experiences and constraints and will have developed their own individual preferences for learning styles.

Considering the complexity of learning it is unsurprising that a plethora of theories have arisen from across a range academic disciplines. However Beetham and Sharpe (2013) point out that rather than seeing them as competing accounts it is more constructive to view them as compatible explanations for a large range of different phenomena. Therefore, rather than replace each other, consecutive learning theories complement each other and each contributes its legacy to learning. Whilst both the NHS and non-NHS resources, cited above, provide comprehensive information relevant to the design of eLearning, pedagogic content design is only addressed by JISC (2009). JISC identified three broad learning theory perspectives: the associative, constructive and situative. Each of these learning theories is based on fundamentally different learning assumptions and each has individual and identifying pedagogies. Briefly, associative theorists address observable factors and believe that learners gain skills through building associations between different concepts, and that progressively complex actions can be built as a result of component skills. The constructivist perspective focuses on the process that leads to understanding and believes that learners construct their own meaning and rely on using real life experience to build knowledge and problem solve. Finally, the situative approach takes into account the social and cultural aspects of learning theory and claims that learners develop their identities through

participating in communities of social practice (Mayes and de Freitas 2004). Chapter 5 further describes the way in which each of the three learning theories were used to inform the development of this eLearning module.

The aim of the eLearning module created for this study was to support clinicians in practice. Therefore, whilst the learning styles appropriate to its design have included associative and constructivist approaches, the ultimate aim would be for the learner to use the information in a situative way, by integrating it into their previous understanding and thereby constructing their own meanings when applied to clinical practice. As discussed earlier, the strategies promoted by different learning theories overlap and depend on the focus of the learning theory and the level of cognitive processing required. This argument concurs with the strategies used to design this module, in that one single learning theory does not suit all styles of educational material. Ertmer and Newby (1993) stress that the instructional strategy and the content addressed should depend upon the level of the learners. However, in designing training for the multidisciplinary team, each of whom have a differing range of skills and experience, this presents as a challenge.

3.8 Continued professional development (CPD)

The knowledge base for health sciences is continually expanding and therefore it is essential that those providing direct clinical care follow a path of life-long learning in order to keep aligned with new developments and maintain their professional skills. Continuing professional development (CPD) is the process by which health professionals keep updated to meet the needs of patients, the health service, and their own professional development (Peck et al. 2000) and in order to remain on the professional register it is a requirement that knowledge and competence is maintained and evidenced. A further challenge of designing training for CPD is time limitation. Conventional breastfeeding training updates last one hour and this eLearning module addressed the anatomy and physiology of breastfeeding and breast milk

expression but did not provide training on positioning and attachment of the infant at the breast. Therefore, it was important that it could be completed within around 30 minutes in order that the training on other aspects of the course could also be accommodated within the scheduled time frame. Because clinicians have limited time to engage in CPD it was important to ensure that the training was user-friendly, accessible and engaging.

3.9 Active learning

Cook and Dupras (2004) describe the importance of encouraging active learning and ensuring the user is motivated to learn; this can be achieved through self-assessment, reflection, self-directed learning, problem-based learning, learner interaction or feedback. Active learning approaches are those that engage the student in self directed learning and are thought to result in greater retention than more passive approaches (Magnussen 2008). Shulman (2002) identifies engagement, along with motivation, as the first of six stages in the learning process, thereafter follows understanding and knowledge, which the learner can translate into the third stage of performance and action. Initiating and maintaining the attention of the learner through engagement is therefore crucially important in instigating learning.

Justification for module

In order to capture the learner's attention in the design of this eLearning module, information regarding the national and local figures for breastfeeding was presented so that clinicians could contextualise the subject in their own working practice and understand the need for improvement in services. One unique aspect of the NUCAT e portal is that it allows the learner to assess their knowledge and thereby engage in their own learning needs, and this may then act as a motivator for undertaking further training. The NUCAT assessment also stimulates the recall of prior knowledge and therefore helps learners to build on what they already know. Engaging in emotions whilst learning has been shown to affect cognitive performance. Activating a positive emotion as enjoyment, has been associated with deep processing, expansion of cognitive reserve and information retention whilst negative

emotions, such as anxiety, may impede learning (Young et al. 2014). Learning is also enhanced if the individual shows interest or enjoyment of a topic and has been associated with more meaningful processing of text, use of deep-level learning strategies and perception of skills (Schielfe 1999). Therefore in the design of the eLearning module it was important to ensure that learners' were engaged with the subject, understood the rationale for undertaking the training and enjoyed the experience of eLearning. Whilst interactivity, such as discussion, is known to improve learning outcomes it was not possible to include that in the design of this eLearning due to there not being one set period of time when all users were 'on line'. However, a study of health professional experience of eLearning found that audio improves satisfaction and therefore in the final iteration of the module all the teaching content was recorded and short films were made (Cook 2010).

Cognitive Load Theory (CLT)

In order to ensure the learner was given maximum opportunity to process the content of the module, attention was paid to Cognitive Load Theory (CLT). CLT builds upon an established model of human memory that includes the subsystems of sensory, working and long-term memory (Young et al. 2014). Learners have a limited capacity to take onboard new information and process it (Young et al. 2014), and therefore techniques to promote retention of information were employed. No irrelevant or redundant information was included in the content and it was presented in a logical, organised way. Visual and written material was presented for time periods that would allow for the learner to have the opportunity to read it; and photographs or illustrations were used, along with written material, to aid retention of information by locating the subject matter in the image. Distributing the information across auditory and visual media reduces the effort of processing (Young, 2014), therefore short, animated films were designed to play for a few minutes which the user had the opportunity to rewind and repeat at any time, thereby enabling them to control their pace of learning.

3.10 Assessment

The fourth stage in Shulman's (2002) six stages of the learning process is critical reflection. Both Cook and Dupras (2004) and JISC (2009) highlight the importance of integrating self-assessment and reflection in the development of eLearning. This is because reflection helps the learner to stimulate learning through engaging with the difference between their current understanding and new information or through reinforcing their current knowledge (Taylor and Hamdy 2013). Pre-tests and post-tests are one way of achieving this, and therefore the opportunity to undertake a summative assessment in this study allowed the learner to reflect on their level of knowledge post intervention and assess whether they had achieved their learning outcomes or required further support. A downloadable logbook was also provided on the website to provide an opportunity for the learner to reflect on their clinical experience after undertaking the training. According to Shulman (2002) this critical reflection will lead to the final stages of the learning process whereby the learner will be able to apply the concepts learnt (stage 5) and evaluate the results (stage 6).

3.11 Chapter summary

Using technology to deliver course content online provides an opportunity to incorporate innovative ways to present educational material, however it is not without its challenges. Research concerning the design and pedagogic frameworks used to develop eLearning is ongoing and further studies to advance eLearning educational science are needed to explore when to use it and how to use it effectively (Cook 2008). There are a number of published guides that can be used to lead the design process and the ones chosen in this study both informed the process of developing an intervention and guided decisions about what kinds of learning activities would be appropriate to support the pedagogic approach. However, certain design features could not be incorporated due to the nature of the context of the study or due to time or financial limitations. This chapter has described the theory behind the development of the eLearning module. In the final stages of eLearning design, Cook and

Dupras (2004) suggest a pilot testing of the website in order to ensure that it is both user friendly and technically functional, and to allow for modifications and refinements. This study developed the eLearning course over two iterations, Chapter Five will describe in detail the way in which the module was designed and built using the principles and pedagogic approaches described in this chapter.

Chapter 4 Methodology

4.1 Introduction

This chapter describes an overview of research methods and a description of the methods chosen for this study. The discussion will include the underlying philosophical assumptions that underpin educational intervention research design, along with a summary of quantitative and qualitative methodologies and a justification for using a combined approach. Whilst a majority of the educational intervention research literature alludes to medical education studies, they hold direct relevance to the field of allied health professionals and are therefore included in this discussion.

4.2 Educational research

There is a growing demand for evidence-based approaches for educational interventions studies to inform practice and advance the science of health professional education (Reed 2005; Flores-Mateo and Argimon 2007; Cook et al. 2008; Mattick et al. 2012). However, several authors have identified inherent difficulties with educational research, as it is subject to myriad interactions that complicate its science; such as the characteristics of teachers, students and projects, the assessment structure and the social and cultural context in which they are set (Berliner 2002; Cook et al. 2007; Eva 2010; Regehr 2010; Mattick et al. 2012). In their article describing the challenges to systematic reviews of educational intervention studies Reed (2005) highlight key areas that researches need to address in order to mediate the challenge of reporting and reviewing these types of studies (Table 3).

Table 3. Recommendations for Improving the Reporting and Synthesizing of Educational Interventions for educational Researchers (Reed 2005)

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These recommendations are aligned with Smits (2002) call for outcome variables that correspond with study objectives, preferably where several different variables are measured, including participants' performance and patients' health. Cook et al. (2008) also recommend using a structured approach to educational research design and note that many studies fail to follow a line of enquiry that will advance the knowledge in the field. This is in part because they focus on descriptive studies that report on interventions or assessment methods but may not contain outcome data; or justification studies that are geared solely towards testing the efficacy of interventions. Importantly, neither of these types of studies describes the process by which the interventions came about, and therefore fail to inform the development of the next course, curriculum or tool.

Cook et al. (2008) call for an alternative approach, namely clarification studies, as these typically build on theories or prior research and seek to answer the question of how and why

educational interventions work. In this way clarification studies may be more concerned with analysing attitudes or views on the learning experience, than purely measuring the effects of interventions. The hallmark of the clarification approach is the implementation of a conceptual framework that describes the theory-building study of a project that is key to the scientific process. The framework aids in choosing an appropriate research approach through providing a systematic structure to support the rationale for the study. As a result of clarity in the description of this process, findings are made more generalisable and can be used to inform other educational designs (Bordage 2009). In this study the Reeves (2006) model is used to guide the process of design and evaluation.

In a similar view, Regehr (2010) argues that the scientific discourse surrounding educational research should not focus on answers so much as express an understanding of the problem. Findings can be made relevant if it is understood that they may need to be adapted to work in a given context. Importantly, this involves a shift away from simply demonstrating success towards articulating what is learnt during the research process. This study therefore describes the formative stages of the design of an eLearning tool (Chapter Five), how each stage is evaluated and how the findings of the evaluations guided the design process. In order to do this, it includes:

- An explanation of why the chosen study design was the strongest possible with available resources
- A description of the baseline characteristics of targeted learners
- Detail concerning the educational content and teaching strategies
- A description of the context of intervention (setting, timing, targeted learners, and resources)
- Objective evaluation methods when possible
- A report on the reliability and validity of the instrument (NUCAT)

4.3 Epistemological paradigm

The term paradigm was first used by Thomas Kuhn (1962) to denote a framework with a set of beliefs, values, and assumptions shared by a community of scientists regarding the nature and conduct of research. Researchers are urged to locate their research in a selected paradigm because the differences in ontological and epistemological assumptions about the nature of what is being investigated, and how it is to be understood, shape the methods used to explore the research topic. Consequently, the paradigm that the researcher adopts will influence the research method considered best to generate the research questions, identify what data to collect, and inform the interpretation of results (Bergman 2010).

The worldview of the researcher has traditionally been influenced by the positive (quantitative) and constructivist (qualitative) paradigms. Positivism is seen to drive the quantitative approach (Lavelle et al. 2013), a mode of inquiry often used for deductive research where the goal is to measure known phenomena and patterns of association, including inferences of causality. It is based on an assumption that there is a single reality that can be identified through objective measurement. This also requires the experimental control of variables that may affect the outcome variable either through physical manipulation or via statistical analysis. Positivism is criticised by educational researchers as it fails to account for the distinctive character of human social life through exploring what people do and why they do it. Also, it could be argued that it does not recognise the role of the researcher in constructing the phenomena portrayed in data and findings, and can be seen as dehumanising, as it deals in numerical and aggregate terms (Johnson and Onwuegbuzue 2004).

Constructivism is typically associated with the qualitative perspective and is widely used in educational research for the purposes of inductive or theory-development driven research (Ringsted et al. 2011). It has a more interpretative stance and focuses on understanding the meanings articulated by participants, assuming that there are multiple constructed realities as

opposed to a defining, singular reality. Qualitative analysis can explore the ways in which individuals make sense of their world, through exploring their understandings beliefs and attitudes. Methods used for data collection include interviews, ethnographic observation and focus groups, thereby emphasising the voices of the participants through quotes and providing detailed information about setting or context (Sullivan and Sargeant 2011). Qualitative approaches have been criticised for being too vague or variable to provide generalisations across cultures/situations (Denzin 2009).

In response to the stark dualism of previous paradigms, mixed methods emerged early in the twentieth century to be hailed as paradigm in its own right (Johnson and Onwuegbuzue 2004; Denscombe 2008). Mixed methods is a procedure for collecting both quantitative and qualitative data in order to integrate findings for the purpose of gaining a better understanding of the research question (Klassen and Clark 2011). The rationale for this approach is grounded in the fact that when quantitative and qualitative methods are used in combination they complement one another and allow for a more robust analysis (Ivankova 2006). Whilst the focus of this method is on adopting a pluralistic strategy this should not be interpreted as a 'good enough' approach but rather the approach that best fits the research design in question, in order to provide adequate findings. As such, mixed methods incorporate a distinct set of ideas and practices that define it as separate from the other main research paradigms (Creswell et al. 2011).

The strengths and weaknesses of mixed methods designs have been widely discussed in the literature (Johnson and Onwuegbuzue 2004; Morgan 2007; Denscombe 2008; Tariq and Woodman 2013). The main disadvantages are that it can be difficult to collect two types of data concurrently, it requires skills in both quantitative and qualitative data analysis, and it can be time consuming and costly. However, a major advantage of this method is that it creates the opportunity to answer a broader and more complete range of research questions whilst providing stronger evidence for a conclusion through convergence and corroboration of findings (Johnson and Onwuegbuzue 2004). The basic concept of mixed methods is that

through integrating quantitative and qualitative data the researcher is able to maximise the strengths and minimise the weaknesses of each. As such, mixed methods can be seen as an expansive and creative form of research that allows the researcher to follow the research question in order to obtain the most useful answers. Problems most suited to mixed methods are studies that require multiple perspectives and a complete understanding of a research problem or question (Creswell et al. 2011).

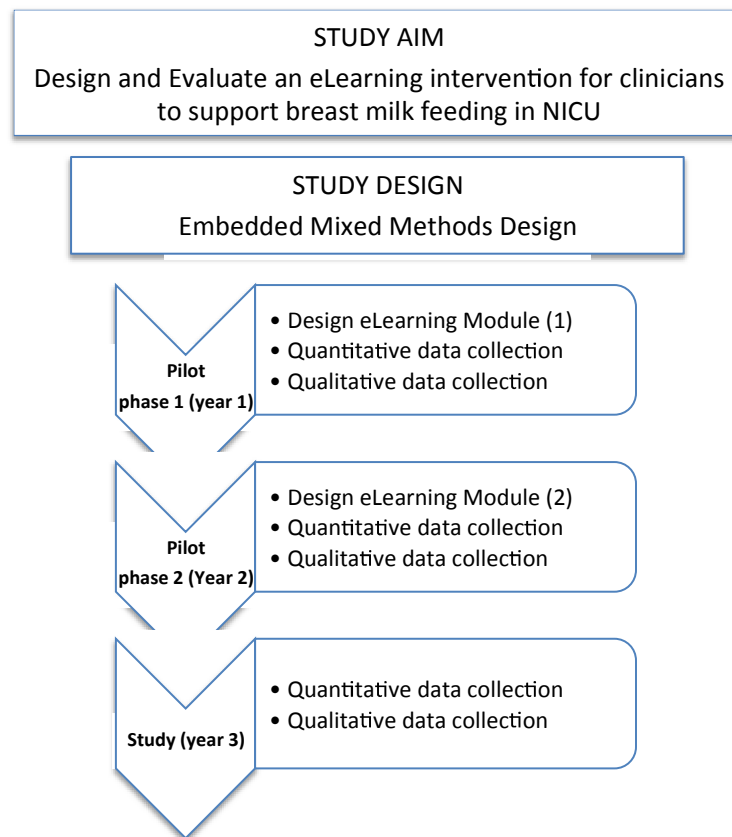
4.4 Methodology for the current research project

Mixed methods

The aim of this study was to both design and evaluate an eLearning module. The sole use of either qualitative or quantitative approaches would have been inadequate to examine the processes that were required to both inform the development and assess the usability of an intervention. This is because whilst data is required to assess whether the intervention can improve knowledge scores this does not provide the necessary information to inform the designer as to which aspects of the training are effective or not. Along with health care research, the mixed methods design is an increasingly popular approach chosen by medical education researchers (Berliner 2002; Maudsley 2011; Lavelle et al. 2013). Following a review of the literature on online learning for faculty development in the medic and nursing population, Cook and Steinert (2013) conclude that the success of eLearning was dependent on the programme itself (what works), the population in which it is being delivered and the context within which it is being delivered. As a result of this they call for the application of the mixed method approach when designing, in order to understand the principles that govern the engagement and success of learners, alongside the evaluation of effectiveness. Therefore, a mixed methods approach was chosen in order to capture not only learning outcomes, but also the experiences of participants undertaking eLearning in order that this could inform iterations of the development.

The integration or mixing of quantitative and qualitative data may occur at several stages in the research process, including data collection, data analysis, interpretation of results, or some combination of these stages (Zhang 2013). When undertaking a mixed methods approach it is important to consider the priority of the methods, and the sequence in which they are used, and this should be driven by the research question (Tariq and Woodman 2013). In this study, the quantitative and qualitative results were analysed in tandem and then embedded into one another to provide new insights. This is known as the embedded (or nested) (Creswell et al. 2011) design that allows for the qualitative data to be used to both inform the design of the eLearning intervention and also to better understand the quantitative results. In this way the integrity of each data is maintained and enhanced understanding can be drawn from combining both data and sets of findings. Insights from using the mixed methods design included an understanding of the clinician experience of using the eLearning module as a form of training, along with a quantitative data set that describes the impact of the training on knowledge and confidence scores. The interview and observation data also explored the effectiveness of the eLearning module and informed its iterative development. The complexity of the mixed-methods designs calls for a visual presentation of the study procedures to ensure better conceptual understanding of such designs by both researchers and intended audiences. Figure 6 shows the study flow diagram.

Figure 6.Study Flow Design



Planned data integration

The integration of the qualitative and quantitative data is the essence of mixed methods research and the formulation of clear and integrated research questions drives this analysis. Bertino et al. (2013) call for separate sets of quantitative and qualitative questions, followed by a specific, mixed method question or an objective that directly refers to the nature of integration. In this thesis both data sets were analysed independently and jointly interpreted to achieve the following objective:

- To use qualitative data to provide illumination and expansion of quantitative findings from the evaluation of the eLearning module

In order to achieve this objective the quantitative and qualitative data were kept analytically distinct and are analysed using techniques usually associated with that type of data; i.e. statistical techniques were used to analyse assessment scores whilst thematic analysis was used to analyse interview data. In using this approach, both the integrity of each data was preserved and an enhanced understanding of the findings was achieved.

4.5 Quantitative methodology

Aims

1. To assess baseline (T0) knowledge of anatomy and physiology of lactation (A&P) and breast milk expression (BME) and how it differs by of job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training. •
2. To assess baseline (T0) confidence in knowledge and practice of A&P and BME and how it differs by job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training.
3. To assess post intervention (T1) knowledge of A&P and BME and how it differs by job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training. •
4. To assess post intervention (T1) confidence in knowledge and practice of A&P and BME, and how it differs by job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training.
5. To measure the mean change between pre and post intervention scores for total knowledge, knowledge in A &P, knowledge in BME, total confidence, confidence in knowledge and confidence in practice from T0 to T1 and whether sustained at follow up T2.

Quantitative study design

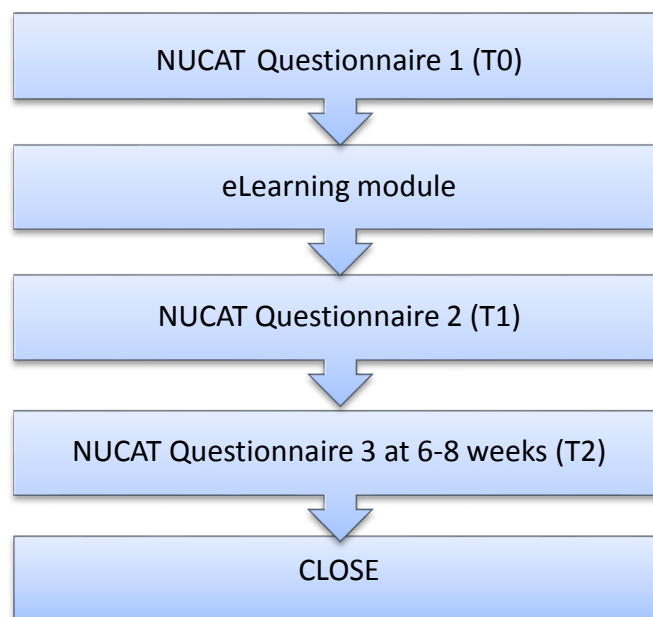
The study design used to evaluate changes in staff knowledge and confidence was a quasi-experimental, single group pre-test/post-test with no control. Quasi-experimental studies encompass a broad range of non-randomised intervention studies. The purpose of randomisation is to control for both known and unknown differences between study groups and is recognised as a requirement for the strongest study design (Norman 2010). However, whilst a randomised controlled trial remains the gold standard in the hierarchy of study designs, it is not always feasible and few educational interventions use this design. The reasons for this have been cited as lack of institutional support, difficulties with blinding and the ethical debate of randomising learners to receive an intervention (Sullivan 2011).

The quasi-experimental design has recognised limitations. In order to establish that the observed outcomes were as a result of the intervention, the potential influence of other factors needed to be minimised. Cook and Beckman (2010) highlight the fact that pre-tests can be seen as threats to the study design because they familiarise participants with post-test questions, stimulate learning and study following the test and heighten awareness of the requirement to study. They argue that in a truly randomised design the baseline knowledge and skills would be equalised and therefore the pre-test would be unnecessary. However, in this study the pre-test is an integral part of the intervention and the answers are not fed back with score results so participants are not aware of which questions they got correct and cannot therefore learn from their mistakes. It is also an important part of the study design that participants are aware of their scores in order that this acts as a motivator for learning and can be used to determine whether their confidence in their knowledge was in fact well placed. Cook and Beckman (2010) also note that pre-tests are better suited to non-randomised designs as is used in this study.

Pre-test/post-test study designs are widely used across a range of scientific disciplines, principally for comparing groups and/or measuring change resulting from experimental treatments. The definitive characteristic of this study design is that (at least) two

measurements are made on the same experimental unit: the pre-test measurement made prior to the administration of a treatment or intervention and the post-test measurement made at a point in time reasonably afterward. In this instance the pre-test serves as the 'control' period as it provides some information as to what knowledge and confidence would be without the educational intervention. It was expected that a majority of the clinicians undertaking the training would have received some prior teaching in breastfeeding support, therefore the pre-test (T0) measured the pre-existing knowledge on the course topic and indicated to the learner the level knowledge expected from them and the content of the course. The Pre-test was undertaken as close to the start of the educational intervention as possible in order to avoid contamination of other variables. The immediate post-test (T1) measured the knowledge scores following the educational intervention and was undertaken as soon as the educational intervention was completed in order to minimise the risk of other factors producing the effect. In order to measure retention of knowledge over time and avoid missing a longer-term effect, the post-test was repeated on one further occasion, 6-8 weeks following completion of the eLearning module (T2) (Figure 7).

Figure 7. Study Three Design Flow Chart



Statistical Analysis

Statistical Package for Social Science (SPSS version 22. 0) was used to analyse the data and the level of statistical significance was set at $p < 0.05$. Dependent variables included breastfeeding knowledge score in the areas of anatomy and physiology of lactation and breast milk expression and self rated confidence scores in confidence in knowledge and confidence in practice. Independent variables included age, job role, length of time working on NICU, percentage of working week spent in direct care of babies and previous breastfeeding training.

Tests for normality

When analysing data using a one-way ANOVA, the dependent variable should be approximately normally distributed for each group of the independent variable. Therefore, in order to test for this assumption, a visual inspection was undertaken of histograms and normal Q-Q plots for knowledge and confidence scores, as assessed by all group combinations of independent variables. One-Way ANOVAs require the dependent variable to be approximately normally distributed for each category of independent variable because it is considered to be robust to violations of normality. Field, (2013) states that with large sample sizes (> 30 or 40), the violation of the normality assumption should not cause major problems when testing for confidence intervals or significance. This therefore implies that this test can use parametric procedures even when the data are not normally distributed (Elliot 2007). In designs in which several groups of participants are tested, a further assumption is that there is homogeneity of variances; this assumption means that each of these samples comes from populations with the same variance. Therefore the Levene's test was undertaken to ensure this assumption had not been violated.

Descriptive analysis

Descriptive analysis reported the number of participants approached, the number agreeing to take part, the number of participants who undertook the pre-intervention NUCAT assessment

(T0), the number who completed the eLearning intervention and undertook the post-intervention NUCAT assessment (T1) and the number who completed the NUCAT assessment at 6-8 weeks (T2). Descriptive statistics also reported the numbers of participants in each independent variable category.

Aims 1 and 2

1. To assess baseline (T0) knowledge of anatomy and physiology of lactation (A&P) and breast milk expression (BME) and how it differs by of job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training. ▪
2. To assess baseline (T0) confidence in knowledge and practice of A&P and BME and how it differs by job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training.

In order to explore aim 1 and 2, an analysis of variance (one way ANOVA) was conducted to determine if there was significant difference between the dependent and independent variables. The ANOVA provides an omnibus test of the differences across multiple groups and can therefore only identify general differences. In order to further explore any significant differences in the ANOVA results, further post hoc testing using the Bonferroni adjustment method was used in order to reduce the risk of type I error.

Aims 3 and 4

3. To assess post intervention (T1) knowledge of A&P and BME and how it differs by job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training. ▪
4. To assess post intervention (T1) confidence in knowledge and practice of A&P and BME, and how it differs by job type, age, length of time working on NICU,

percentage of the working week spent in direct clinical care of babies and previous breastfeeding training.

In order to explore aims 3 and four a two way mixed design ANOVA was conducted to compare T0 and T1 mean total confidence and total knowledge scores to determine if there was a significant difference between the dependent and independent variables. Repeated administrations of the NUCAT at two points in time: baseline (T0) and post intervention (T1) functioned as the repeated measures factor (Time) at two levels. The dependent variable was the NUCAT score. In order to further explore any significant differences in the ANOVA results, further post hoc testing using the Bonferroni adjustment method was used in order to reduce the risk of type I error.

Aim 5

5. To measure the mean change between pre and post intervention scores for total knowledge, knowledge in A &P, knowledge in BME, total confidence, confidence in knowledge and confidence in practice from T0 to T1 and whether sustained at follow up T2.

To measure the mean change between pre and post intervention scores for knowledge and confidence in practice and confidence in knowledge, repeated-measures analysis of variance (ANOVA) was conducted on scores by time (Time 0 vs. Time 1 and Time 1 vs. Time 2). An analysis of variance (ANOVA) is used to assess one dependent variable measured several times. The repeated measures ANOVA is used to test the effects of a continuous dependent variable measured several times. The continuous dependent variable of the analysis is the confidence and knowledge scores, measured 3 times. The *F*-test of significance is used to assess the effects of time. If significance is found, pairwise comparisons will be done to assess where the differences lie. The assumptions of ANOVA include: the dependent variable must be continuous/interval and normally distributed, which will be checked with skewness

and kurtosis values, and sphericity, which will be assessed through a Mauchly's Test of Sphericity (Field 2013).

4.6 The eLearning intervention

The eLearning material was developed for this study through an iterative process and is the subject of separate pilot studies (Study One and Study Two). The details of the pilot studies are presented in Chapter Five. The eLearning intervention was delivered through the same secure site as NUCAT. It included factual knowledge about the anatomy and physiology of lactation and breast milk expression. Full descriptions of its contents are outlined in Chapter Five, section 5.2.1 and section 5.3.1.

4.7 Measures

Knowledge

The relationship between assessment and learning is complex and dependent on extraneous factors such as the learning environment, students' perceptions of assessment demands and their attitudes to learning (Al-Kadri et al. 2012). Historically, the main purpose of assessment has been to determine whether a student has successfully completed a course, and is epitomised by either the passing or failing of a summative examination. However, Schuwirth and van der Vleuten (2011) argue that assessment *for* learning, alongside assessment *of* learning, provides benefits to learners and can therefore be used to enhance the learning process. Educators and researchers have recognised that formative assessment plays an important role in conducting learning activities for improving student learning effectiveness (Bell & Cowie, 2001) as it enables the learner to identify areas of knowledge gaps that they may not have been aware of. In their literature review of assessment factors that contribute to students' study factors Al-Kadri et al. (2012) note that whilst formative assessment may contribute to students' deep approach to learning, summative assessment is likely to reinforce a surface approach.

The NUCAT knowledge test is in the format of multiple-choice questions with 4 answers, only one of which is correct. This study modified NUCAT in order that only the information used in the eLearning module was tested. The total number of questions included 20 items: 10 questions tested anatomy and physiology of breastfeeding knowledge and 10 questions tested breast milk expression knowledge. Participants received the percentage of scores they achieved correctly in each domain and in total at the end of the test. This result was not shared with anyone other than the relevant study participant, and the researcher could not access individually identified scores.

Confidence/Self-Efficacy

Self-efficacy refers to an individual's confidence in his or her ability to perform a particular task or skill (Bandura, 1977). This is because knowledge alone may not necessarily be enough to affect behaviour, but rather it is dependent on the interplay between a person's self-belief, behaviour and a situation. Self-efficacy beliefs are important determinants of motivation and action and influence decision-making and personal determination to undertake a task. Bandura suggests that self-efficacy can be increased in four ways: personal mastery, (ones own personal success particularly when in a challenging situation); vicarious experience, (modelling others' success); verbal persuasion and other social influences.

The clinical development of staff is crucial to building confidence, developing critical thinking skills, increasing skill sets and providing a high quality service. Limited knowledge and a lack of experience can result in low confidence that in turn can adversely affect patient care and potentially cause dangerous situations to arise (Duchscher 2008). A review of intervention studies that focused on increasing the breastfeeding knowledge, self-confidence, and supportive behaviours of healthcare professionals showed that education can increase staff self efficacy in supporting mothers with breastfeeding (Kronborg et al. 2008; Watkins and

Dodgson 2010; Ingram et al. 2011; Toyama et al. 2013). However, these studies were not conducted in NICU nor specifically focused on supporting breast milk expression.

Bandura (2006) warns against the use of a generic 'all purpose' measure of self efficacy as such scales have limited predictive ability, and as they are detached from any given context, provide little informative value. Therefore, self-efficacy scales need to be developed in order to fit with the particular behaviour that is being studied. In this study, NUCAT was used to measure self-reported clinician confidence both pre and post eLearning intervention. Two types of confidence were assessed: (1) confidence in knowledge and (2) confidence in practice to support breast milk expression both by hand and by breast pump. Each item was measured using a 10-point Likert scale (1 = not at all confident; 10 = completely confident). The score was calculated by adding the scores for each question. Content validity was established by review of the items by expert clinicians knowledgeable in the field of breastfeeding. The Cronbach's alpha coefficient for NUCAT was 0.91, indicating good internal consistency (Cronbach 1990).

NUCAT

Development

The Neonatal Unit Clinician Assessment Tool (NUCAT) is a new method of assessing clinicians' knowledge and confidence in skills that support breastfeeding practices and engage parents in the care of their baby in NICUs. NUCAT was commissioned by the child health charity Best Beginnings and developed by Coventry University's Health Behaviour Research Limited as part of a larger evaluation of the Small Wonders Change Programme (Farnworth and Baum 2012). NUCAT question items were derived from an existing, validated breastfeeding knowledge assessment tool, The Coventry University Breastfeeding Assessment (CUBA). CUBA meets the BFI global standard to promote breastfeeding and was originally designed to assess a wide range of breastfeeding knowledge and skills. CUBA has been used in studies internationally and within the West Midlands, but not specifically in neonatal

units (Wallace et al. 2011; Weddig et al. 2011a). In order to develop NUCAT, an expert panel, set up by the charity Best Beginnings, reviewed the items selected from CUBA and produced additional items specific to neonatal care.

In its original form, NUCAT consisted of an on line measure with 11 personal descriptive questions, 8 confidence items using a 10 point scale covering confidence in knowledge and confidence in practice, and 66 multiple choice knowledge items where only one of four options is correct. Questions covered factual knowledge as well as observation of clinical scenarios (using still clinical photographs and video clips from Best Beginnings' Small Wonders DVD, and Health Behaviour Research Essential Skills DVD). The knowledge areas had several items to create coverage of key topics: Positive Touch, Kangaroo Care, Breast Milk Expression, Positioning and Attachment, Anatomy and Physiology of Lactation, and the Benefits of Breastfeeding. The two breastfeeding scales (Positioning and Attachment, Physiology of Lactation) and some items within the Benefits of Breastfeeding and Breast milk Expression, were developed using items from an existing validated breastfeeding knowledge test (CUBA) referred to above. In this study the question items were selected from the Anatomy and Physiology of Lactation and Breast Milk Expression sections.

NUCAT stages:

1. **Registration stage** – researcher loads participant details onto website database and participants are allocated and emailed a unique identifying username and password.
2. **Consent** – Participant receives email via website providing them with log in details and inviting them to confirm they are happy to consent to take part. They log in via email link and tick all boxes required to consent and enter the NUCAT questionnaire website.
3. **First NUCAT Questionnaire stage** – Participant completes first NUCAT questionnaire and survey immediately pre intervention. Feedback on percentage scores for each section is given and a thank you email is sent.

4. **NUCAT training** – Participant is invited to undertake eLearning module once NUCAT complete. The eLearning module is located within the same e portal site as NUCAT and participants can spend as much time using it as they wish.
5. **Second NUCAT Questionnaire completed** – user completes second NUCAT questionnaire and survey immediately post intervention. Feedback on percentage scores for each section is given and a thank you email is sent.
6. **Third NUCAT Questionnaire completed** – user completes third and final NUCAT questionnaire and survey 6-8 weeks post intervention. Feedback on percentage scores for each section is given and a thank you email is sent.

Validation

In order to ensure that the inferences made from a test are justified and accurate (i.e. that the test score reflects the knowledge of the participant), it is necessary to undertake validation processes. An earlier study by Wallace et al. (2013) piloted NUCAT and provided evidence of its external validity as it found significant differences in the baseline sub-group analysis. Total knowledge scores achieved by participants ranged from 29 to 53 (range 0-66) indicating the assessment tool had a good variance. Also, doctors achieved higher knowledge scores than nurses in the sub-section of benefits of breast milk, showing validity in distinguishing different knowledge levels. Interviews with 8 participants reported that NUCAT helped them to identify their knowledge gap and further training needs, supporting the usability of NUCAT. NUCAT was originally piloted on a small number of clinical staff to test the ease of understanding the questions and the usability of the on line system. Cronbach's alpha coefficient was examined and reported the internal consistency for the NUCAT confidence score. Ideally, a consistent scale where all items are measuring the same domain would have an alpha of 0.70 or over. The internal reliabilities of the sub scales (Cronbach's alphas) were above 0.7.

4.8 Procedure

Research site

University Hospitals Coventry and Warwickshire NHS Trust (UHCW) is a busy, tertiary neonatal unit that has over 600 admissions per year and around 150 clinical staff. The breastfeeding rates in UHCW are improving but remain below the national average; therefore further efforts are required to ensure it can improve its breastfeeding services. In 2013, The National Neonatal Audit Programme (NNAP) published figures showing that 49% of babies born at less than 33 weeks gestation at UHCW were discharged home receiving any breast milk compared with a national average of 59%. Local figures indicate that rates for exclusive breastfeeding at discharge are even lower, at around 37%. Whilst striving to meet UNICEF BFI standards, (UHCW maternity unit has achieved stage 1 commitment), the Trust did not achieve its stage 2 assessment in May 2011 and is currently working towards this level of accreditation. It is a local requirement at UHCW that all nursing staff attend a face to face teaching session that is delivered over one or two days, once every three years, along with an annual, one hour update. This training is usually delivered by the breastfeeding nurse lead in the hospital and the main content focuses on breastfeeding healthy babies; currently there is no assessment to measure the effectiveness of this training in terms of knowledge outcomes and, as mentioned above, it is known that breastfeeding rates are below the national average on discharge from NICU.

Participants

The subjects in this research were clinicians who work on the neonatal unit at University Hospital Coventry and Warwickshire NHS Trust. All clinical staff were eligible to undertake NUCAT and the eLearning module.

Inclusion and exclusion criteria

Staff who fulfilled the following eligibility criteria were invited to participate in the study:

Inclusion criteria

- Working directly with breastfeeding mothers
- Working in NICU
- Job types of student midwives, nursery nurses, neonatal nurses, junior doctors and paediatricians

Exclusion criteria

- Working in NICU, but not directly caring for breastfeeding mothers

Recruitment

A formal sample size calculation was not undertaken, due to the exploratory nature of the study although strenuous efforts were made to recruit the largest possible sample (Polit and Beck 2009). The researcher was responsible for identifying potential participants briefing them about the eLearning intervention and NUCAT. Posters were placed in the coffee room and in corridors on the NICU inviting clinicians to contact the researcher if they wished to take part. The researcher was given permission by NICU senior management to send all clinicians an invitation email, along with a copy of the participant information sheet (PIS) (Appendix 2). They also spent time on NICU approaching individual clinicians to invite them to take part and provide them with hard a copy of the PIS.

In order to consent for name and e-mail to be used in the survey management system, clinicians were asked to consent via paper form or by responding to an email – i.e. an opt-in process. Briefing and consenting staff for the study was the responsibility of the researcher. Those who did not wish to participate did not provide their email details. The researcher had “administrator access” to the survey sample and once participants consented to provide their details, either on paper or by email, they were directly uploaded into the fields in the website

detailing the participants e-mail and name. The researcher controlled and customised the invitations to staff that were then issued via the website. Participants received an e-mail sent from the NUCAT website managed by Coventry University's spin out company Health Behaviour Research Limited (www.healthbehaviourresearch.co.uk) inviting them to log in using a unique code. The site had a record for each person of their "status" i.e. progress through the stages of recruitment to completion. The PIS and consent forms (Appendix 3) were downloadable in printable form and integrated within the NUCAT site. Before they entered NUCAT, participants were invited to review the PIS and tick the consent page. The web-administered training and survey enabled the participant to complete the test in one sitting from any Internet enabled PC. The researcher could inspect the website to see the progress of each person but did not obtain any information on the survey results on this system. If needed, participants were sent email reminders to complete NUCAT and the eLearning intervention.

Data protection and participant confidentiality

Participants were given a unique username and password to access and complete the NUCAT survey. The NUCAT survey was accessed through a secure web platform that was specifically designed to host it. The data was stored on this web platform and could only be accessed by the researcher (again with a secure username and password). Once all staff had completed the training the NUCAT survey the data was downloaded into an Excel spread sheet. During this download process each staff member was assigned a unique identifying code to preserve anonymity and confidentiality. NUCAT was administered on a secure socket web site. The data was stored by participant code not name, and data was held in the website until downloaded by the researcher for analysis.

4.9 Qualitative methodology

Historically, medicine and health care have been largely dominated by quantitative or experimental approaches to research, defined as the systematic collection of numerical

information usually within controlled conditions using deductive processes of knowledge attainment (Streubert and Carpenter 1999). Qualitative research is often given the label of 'soft data' whereas quantitative work is considered to be 'hard data' and is subsequently viewed as more 'scientific'. Qualitative research has been criticised as anecdotal, unreliable and invalid and as such carries with it 'negative inferences' for those undertaking qualitative projects (Denzin and Lincoln 1998). However, qualitative, or non-experimental approaches have long been associated with social sciences and are concerned with humanistic understanding (Robson, 1993). Using the qualitative approach, data can be collected from within natural environments and includes the social, cultural, experiences and feelings experienced by an individual in any given society (Streubert and Carpenter 1999). Implicit in this approach is that there are multiple subjective realities, which are constantly in flux. In contrast to the quantitative survey method, therefore, qualitative data are typically collected through in-depth interviews, focus groups, or participant observation, which are better able to capture the subjective dynamics of individual experience.

Because this study aimed to gather rich, detailed information reflecting the participants' viewpoints, it was decided that the most appropriate methodological approach for exploring perceptions of experiences would be qualitative interviewing. The interview method has several advantages for data collection as direct contact with participants can enable the researcher to obtain detailed information whilst pursuing specific areas of interest or concern. In health care, information on phenomena such as attitudes, opinions and perceptions are of key importance to informing the understanding of the patient experience and the design of services. Qualitative research is particularly suited to this type of research question because it focuses on understanding the way in which people make sense of their lived experience. Depending on the requirement and design, interviews can be unstructured, structured or semi-structured with individuals or focus groups. The exploratory methodology chosen in this study was semi-structured interviews.

4.9.1 Evaluation

Evaluation is a key aspect in the development of an eLearning intervention as clear communication between developers and participants potentially serves to provide feedback that may highlight specific aspects of the intervention, such as course design and structure that require improvement (Dorrian and Wache 2009). This study adopted a framework that integrated evaluation into the design in order that data from iterative studies could inform future, necessary revisions. This was then reassessed to measure the effects of those changes and is presented in the pilot work Chapter Five.

Aim

- To evaluate the NUCAT assessment and eLearning module using question analysis and user feedback.
- To measure the eLearning module's usability through survey questions built into NUCAT

Question Item analysis

In order to ensure that the content was relevant to the learning outcomes, as measured by the NUCAT assessment, data was collected and simple item analysis (looking at the participants scores for each question) was undertaken. Question analysis was also performed in order to eliminate ambiguous or misleading items and identify specific areas of course content that may need greater emphasis or clarity. Where an item was found to have performed poorly it would be discussed within the supervisory team and action taken to modify the assessment or the eLearning module.

User feedback

Survey questions can be used to probe for emotional values, such as satisfaction or approval, and for specific information such as the amount of time participants spent on eLearning. In this study participants were invited to suggest improvements regarding any aspect of

educational content or design. The six survey questions used in this study were designed to gather feedback on aspects of course design, development and implementation.

In order to gain user feedback in this study the following questions were asked:

1. How helpful was it to have the feedback of your percentage scores at the end of the NUCAT assessment?
2. How would you rate the ease of use of the NUCAT e portal?
3. How long in minutes did it take you to complete the NUCAT eLearning module approximately (exclude any time taking breaks)?
4. In what ways do you think the eLearning module could be improved?

4.9.2 Clinician interviews

Aim

To undertake semi-structured interviews with clinicians who completed the eLearning module and NUCAT assessment to ascertain their views on:

- a. The usability of the eLearning module and NUCAT assessment
- b. Their experience of undertaking the eLearning module and the relevance of its content
- c. Their experience of providing breastfeeding support on NICU
- d. Their experience of previous breastfeeding training

Criteria

The study aimed to interview between six and ten clinicians, across a range of job types and neonatal experience, as this should provide sufficient variation in participants to allow for contrasting opinions. Interviews were conducted in Study One and Study Three. The potential participants were identified through working on the neonatal unit during the period of time

that the intervention was being evaluated. A selection of clinicians, who consented to undertake the eLearning, were asked to consent to be contacted for an interview.

Participants and research Site

Because the evaluation process was part of the NUCAT assessment the participants and recruitment process are identical to that in section 4.8.

Recruitment

Participants who had completed NUCAT were invited to undertake an interview in work time in both Study One and Study Three. The non-random method of purposeful sampling was used in order that the researcher could select 'information-rich' cases for study in depth (Patton, 2002). Clinicians undertaking differing job roles were selected in order to gain a broader perspective on the impact of the eLearning on different job types and to capture a breadth of staff knowledge and experience regarding the practices and experiences of supporting mothers. The estimation of sample size was made based on the analytical framework chosen to interpret the interviews and the subject matter. A sample size of between 6 and 10 was chosen because the research question has a fairly narrow focus (clinician experience of undertaking the eLearning module and supporting mothers with breastfeeding on NICU). However, if the sample size was found to be inadequate in terms of reaching saturation i.e. new themes were still emerging in the interviews, the researcher recruited further participants to ensure the breadth of experience was captured.

Consent

Clinicians were given a minimum of 24 hours to decide if they wished to take part in the study and were given the opportunity to read the participant information sheet (Appendix 4). They were then given the opportunity to ask any questions they may have had concerning taking part in the study prior to giving written consent.

Method

Each participant was approached with the information sheet regarding the study, containing

an explanation of the nature of the interview, the length of time it will take (approximately 30 minutes) and that it will be audio-recorded and arranged at their own convenience. They were given the opportunity to read the information sheet and discuss any queries they may have regarding the study with the investigator. The interviewer did not wear formal clothing in order to avoid the implication of a hierarchical order that may impede the interaction between investigator and participant.

The participants were interviewed on only one occasion and interviews consisted of open-ended questions that defined the area to be explored and from which ideas may be pursued in more detail. Semi-structured interviews were selected as a means of data collection because they are well suited for the exploration of perceptions and opinions of respondents regarding complex and sensitive issues. The method of semi-structured interview was decided upon because a qualitative, descriptive inquiry requires a minimum of researcher-imposed structure and a maximum of participant involvement through the use of both closed and open questions. In order to be consistent with all participants, the researcher used set of pre-planned core questions for guidance in order to ensure that the same areas are covered with each interviewee (Appendix 6).

Interviews were conducted face-to-face by the researcher in a private room on NICU in UHCW and recorded digitally. Each interview began with interviewer briefly explaining the background, aims and nature of the study. Then the participants were invited to provide an overview of their job role and length of time working on NICU. Following that the researcher asked the questions derived from the framework. Each participant was asked the same questions within a flexible framework. However, whilst a schedule of interview questions was used, there was also the opportunity to probe for clarification and further information allowing the interviewee to elaborate or provide more relevant information they opt to do so. The imposition of structure through solely predetermined questions could restrict the amount of experience revealed, therefore the open nature of the questions was aimed to encourage depth and allow concepts to emerge. This was important in order to fully explore the participant's experience. During the interview process, if the discussion began to focus on

particular issues, the interviewer asked follow-up questions to explore the issue in greater depth. Or, if the discussion moved off a tangent the interviewer allowed it roam before going back to the questions.

Analysis

There are several qualitative analysis methods including interpretative phenomenological analysis (IPA), Grounded Theory (GT), Discourse Analysis and thematic analysis. The central objective of IPA is to understand what personal & social experiences mean to the people who experience them (Shaw, 2010), whilst recognizing that this is an interpretative process involving both the researcher and the participant. This type of approach is particularly suited to small sample sizes and studies that have no predetermined hypothesis. Grounded theory is used to describe the inductive process of identifying analytical categories as they emerge from the data, rather than using predefined hypotheses (Pope et al. 2000). The 'constant comparative method', developed as part of GT, involves making systematic comparisons across cases to refine each theme and is concerned with generating social theory (Gale et al. 2013). Discourse analysis, focuses on text and talk as social practices, and looks at both patterns in linguistic repertoire and rhetorical strategies. As such, it indicates a method of data analysis that can tell us something about the discursive construction of social reality (Smith 2008).

Framework Analysis (FA) sits in a broad category of analysis known as thematic analysis. This method was selected because it is particularly suited to qualitative design in which the objectives of the investigation are typically set in advance and shaped by information requirements. This approach is increasingly used in applied healthcare policy research when specific 'a priori' questions have to be explored. It is also well suited to mixed methods research when quantitative data are also available (Gale et al. 2013).

Interview transcripts were printed and analysed on paper. The first stage of FA is familiarisation with the data; this process involves listening to recordings and reading

transcripts in order to list key ideas and recurrent themes. The second stage involves identifying a thematic framework through drawing on a priori issues and questions derived from the aims of the study as well as views and experiences that recur in the data. Following this a thematic framework is applied to the data in order to index themes using numerical codes or short text descriptions. Charting is then performed in order to rearrange the data according to which part of the thematic framework to which they relate. This creates key subject areas or themes that may contain several respondents' entries. Finally mapping and interpretation involves looking at the relationships between the codes with a view to providing explanations for the findings (Pope et al. 2000). This process is influenced by the original research objectives as well as the emerging themes. The outcome of this process is largely descriptive, with quotes from the original material often being used to illustrate the findings reported.

Triangulation of the data took place, using data derived from both the interviews, user feedback and field notes. This process allowed for a more comprehensive approach to data analysis as it allowed analysis of data from more than one angle.

Validity and reliability/rigour

In order to enhance the rigour and trustworthiness of the interview data, the researcher used an audit trail to continuously record the progress of the research as well as investigator responses to interviews (Tracy 2010). In order to avoid biased sampling the researcher adhered to the sampling criteria to ensure a breadth of job role and experience was captured. The interview schedule was designed to minimise the risk of leading questions, to avoid influencing the interviewee's response. The advantages of an interview schedule are that they make data collection fairly systematic for each respondent. However the researcher was aware that this may also lead to important and salient topics being inadvertently omitted and was therefore alert to this. The way in which interviews are conducted can also influence their validity and reliability. The researcher carefully followed the interview schedule in sequence, in order that responses could be made more comparable, thereby increasing

reliability. Cohen et al. (2013) suggest that a skilled interviewer should structure the interview well and know their subject matter in order to be able to conduct an informed conversation, and in this case the researcher is a highly experience ANNP who is extremely knowledgeable in the clinical subject matter. However, inter-rater reliability of the analysis was not conducted as only the researcher coded the interviews. The voluntary nature of the sample and potential for participant bias was recognised and taken into consideration when interpreting the findings.

4.10 Ethics

Prior to the study commencing, ethical approval was granted from Coventry University research and ethics committee (ref P9165) and governance approval was sought and approved by the local Research Development and Innovation (RD & I) department at UHCW NHS Trust via the Integrated Research Application System. This study complied with the Data Protection Act 1998. All the information provided by participants was kept confidential unless it was believed that they or someone else was at risk of serious harm in which case we would tell the participant before the information is passed on to the neonatal ward manager. All data, was kept in a password protected folder. All electronic information will be archived for 3 years following the completion of the study, after which it will be deleted. Responses were identified by the participant code number in the survey system and eLearning module and in downloaded data used to analyse all participants' data recordings.

Ethical issues in testing

In order for testing to be ethical it is important that test are made valid and reliable (Cronbach, 1990). The validity of NUCAT is described in the section above and during the pilot phases of this study further item analysis of the questions was undertaken to further strengthen the reliability of the test. Tests should also benefit the testee and they should not be harmed by the results (Cohen et al. 2011). NUCAT question items were designed to explore clinician knowledge and stimulate their interest in the subject. It was made clear to

participants that the test was designed to benefit them in understanding their learning needs and the results were for their own private interest. Participants were also encouraged to leave feedback regarding the question items to provide feedback as to their suitability. In order to ensure tests are ethical it is important that suitably qualified people undertake administration and marking and privacy and dignity of individuals should be respected (Cohen et al. 2011). In this study the test was administered online and the marking was automated, thereby ensuring consistency. Anonymity and confidentiality were ensured through the NUCAT process as explained in the procedure section above.

Ethical issues in interview

All participants gave informed consent and were given anonymity. As the interviewer is a member of staff on the unit, they could be seen as an 'insider researcher'. Inside research can lead to a danger of being too close to the subject matter to either be able to recognise its significance or be critical of it. However there may also be advantages to being an 'insider' as the interviewer has a great deal of background knowledge (Brannick and Coghlan 2007). Potential benefits of this included an understanding of the professional concerns of clinicians in neonatal units and knowing when a response may deserve further probing (Sofaer 2002). Insider-research projects require the researcher to undertake a process of reflexivity and in this study regular meetings with the supervisor were undertaken in order to ensure that the researchers perspective was maintained. There was also the possibility of bias as interviewers can influence the responses of participants in many ways, even by their tone of voice. A 'response effect' can arise, for example, out of the eagerness of the respondent to please the interviewer or from a tendency by the interviewer to seek out answers that support preconceived notions. Through an awareness of these issues and the use of a reflective approach supported by field notes, written after each interview, the researcher hoped to minimise bias. This reflective approach continued throughout analysis of the data. It was possible that the researcher could uncover issues of professional concern (e.g. undesirable unsafe practice). In these cases, the researcher would discuss the issue immediately with her

clinical and academic supervisor and deal with the issue in line with her professional code of conduct. Where possible, the researcher would endeavour to maintain confidentiality. However, in the event of a serious incident this would not be possible. In order to ensure staff did not feel obliged to take part in interviews they were given space and time to consider their decision.

4.11 Chapter summary

This chapter has outlined the research paradigm, research methodologies, strategies and design used in the study, including procedures, participants, data collection tools, data collection and analysis methods, and data credibility issues. The methodological design for this study was mixed methods, incorporating both a quasi-experimental pre-test/post-test quantitative study alongside in depth semi-structured interviews and survey question data. Analysis was undertaken to measure both knowledge and confidence changes in participants following an eLearning intervention to support breastfeeding on NICU, and to explore the experience of clinicians that support mothers with these practices and the experience of the mothers themselves in providing breast milk for their infant. Further, this chapter has also briefly described the several stages involved in the design and development of the eLearning intervention. The following chapter presents pilot work for the main study and provides a full description of the evaluation process that led to the design of the final eLearning intervention.

Chapter 5 - Development and Evaluation of the eLearning Module

5.1 Introduction

Chapter 3 described the stages required in developing an eLearning intervention following the principles laid down by JISC (2009) and Cook and Dupras (2004). Chapter 4 described the research methods chosen for this study, including a justification for using a mixed methods approach. This chapter will describe pilot work undertaken in two separate studies during the iterative development of the eLearning module. It will focus on the methods and processes used to develop and evaluate the intervention and how these results helped to inform its redevelopment. The structure of the development and evaluation followed an educational design-based framework identified by Reeves (2006) (Figure 8). A key aspect to design-based research is that it addresses complex problems in real contexts in collaboration with practitioners (Herrington et al. 2007). Therefore all the work for this pilot study was undertaken on site at UHCW with neonatal clinicians.

Figure 8. Reeves (2006) stages of educational design research

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5.2 Stage 1 - Identify and analyse problems by researcher and practitioners in collaboration

In order to develop relevant learning material for this study, it was first necessary to identify the 'problem' highlighted in Reeves' (2006) educational design model. As discussed in

Chapter 2, whilst breastfeeding confers enormous benefits on preterm and sick babies, breastfeeding rates in NICU remain low. Strategies to improve breastfeeding outcomes include staff training initiatives. However staff are not always able to identify their own learning needs and may not be aware that they lack knowledge (Wallace and Kosmala-Anderson 2006a). Rigorous knowledge assessment plays an important role in establishing the training needs of staff (Renfrew et al. 2006). This study is unique in its approach because it develops an eLearning training intervention within an online assessment to test neonatal clinicians' breastfeeding knowledge (NUCAT) pre and post intervention. One key aspect of using the online knowledge assessment is that it generates information regarding the learning needs of the practitioners who use it. In order to identify the problem specific to the population being studied, findings from an earlier study undertaken in the same NICU in Coventry, that used NUCAT to measure clinicians' knowledge and confidence in supporting breastfeeding practices (Wallace et al. 2013), were used to inform the development of the solution.

Wallace et al. (2013) assessed the learning needs of staff who support breastfeeding in NICU. This study piloted a version of NUCAT that included an online objective knowledge test comprising 66 multiple-choice questions. These focused on knowledge regarding the physiology of lactation, breastmilk expression, the benefits of breastfeeding, positioning and attachment, kangaroo care and positive touch. Further questions explored clinicians' confidence in both their knowledge and their practice in supporting breastfeeding on NICU. In the study undertaken by Wallace et al (2013) 51 clinicians completed the NUCAT assessment (see Flow Chart 2 pg. 25). Job types included neonatal nurses, nursery nurses, student nurses and doctors. Whilst this was only just over half of the clinical staff on the unit, those who took part were in similar proportions by job type to those who did not, which strengthens the chances that they would be representative of all the staff on the unit.

Figure 9 shows the percentages of correct questions scored in each subject area. Staff had greater knowledge in the areas of breast milk expression, positive touch and kangaroo care,

with lower scores on breastfeeding practices, the benefits of breastfeeding and the physiology of lactation.

Figure 9. The proportion of clinicians who scored in each quartile for the total score and for each of the six knowledge areas on NUCAT from study by Wallace et al. (2013).

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Wallace et al. (2013) found no significant difference in total knowledge scores between job types, training and experience, supporting the importance of ensuring that all staff receive training. However, doctors scored significantly higher than neonatal nurses on the sub section 'benefits of breast milk' ($F(3,47) = 3.197, p < 0.05$), suggesting that nurses may not have the necessary knowledge to provide accurate, evidenced based information to help mothers make decisions about breastfeeding, and could therefore benefit from further education. Clinicians' confidence in knowledge and confidence in practice of breastfeeding support skills in NICU were measured both before undertaking NUCAT and post assessment, after having received feedback of their knowledge scores (Table 4). Paired t-tests found that confidence in

knowledge significantly decreased when staff were fed back their results, suggesting that staff overestimated their knowledge of breastfeeding. However confidence in practice was not significantly reduced.

Table 4. Clinicians' ratings of their confidence in knowledge and confidence in practice to support breastfeeding

NUCAT Confidence Questions (1-10, ↑ = more confidence)	Pre- Knowledge test Confidence mean score (SD)	Post- Knowledge test Confidence mean score (SD)	<i>p</i> value
How confident are you to support women to breastfeed?	6.08 (2.15)	5.76 (1.97)	<i>p</i> = 0.09
How much do you feel you know about supporting women to breastfeed?	6.61 (1.81)	5.94 (1.83)	<i>p</i> < .001
How much do you feel you know about breast milk expression?	6.29 (2.11)	5.63 (1.95)	<i>p</i> < .001
How much do you feel you know about the physiology of breast milk production, expression and breastfeeding?	5.84 (1.93)	5.25 (1.83)	<i>p</i> < .01
How much do you feel you know about the benefits of breastfeeding for babies and mothers?	7.47 (1.45)	6.24 (1.69)	<i>p</i> < .001

Clinicians' scores were lower in the knowledge area of physiology of lactation, where two thirds (n=33) (65%) scored half or more correctly, and interviews identified that this topic was not a focal part of the training that they had received. Knowledge scores for breast milk expression showed that 47 clinicians (92%) scored half or more correctly. However, further interview results identified a lack of confidence and inconsistency in advice given to mothers regarding breast milk expression.

As a result of these findings (Wallace et al. 2013), specific learning needs were identified that informed the development of the content for the eLearning module. Breast milk expression and the physiology of breast milk production were identified as areas of knowledge that may require further educational support. It is important for clinicians to understand the anatomy and physiology of lactation because this knowledge will inform their ability to assess and facilitate effective breastfeeding, and may also help them to both manage and prevent common problems. Further to this, breast milk expression is key to the success of providing breast milk for a baby in NICU. An eLearning module was chosen as the preferred method for delivering educational content because it could be integrated with the online assessment process and thereby provide a 'one stop' access point for clinicians to both assess and meet their learning needs. Whilst eLearning has been found to be at least comparable to traditional training, learner engagement and participation can be highly variable and success is therefore more likely when the course addresses a relevant need, facilitates communication and social interaction and provides time to complete course activities (Cook and Steinert 2013). Therefore, a key aspect to the design of this learning intervention was its relevance to the educational requirements of staff and its use as a guide to supporting clinical practice.

5.2.1 Stage 2 – Study One

First iteration in the development of prototype solution –

ELearning Module (Version One)

Learning aims and objectives

Once the learning need has been identified, the second stage in the Reeves (2006) educational design model is to develop a prototype solution informed by existing theoretical knowledge, design principles and technological solutions (Teräs and Herrington 2014). Chapter 3 described the theory behind the development of this eLearning module guided by both Cook and Dupras (2004) and JISC (2009). Both publications highlight that the first step in developing educational material is to develop effective instructional methods that are carefully aligned with learning objectives; therefore this was the first step in the development of this eLearning module (Table 6).

In order to ensure an integrated approach to learning, the learning objectives of the online teaching and the clinical environment must be consistent. In the UK, the UNICEF BFI provides a framework for the implementation of best practice by NHS trusts, in order that they can meet the required standards and can be assessed and accredited as Baby Friendly. Therefore, the module content in this study was specifically aligned to the UNICEF BFI standards (Appendix 1) that are currently used to teach health professionals within the hospital setting. Table 5 describes the learning content of the UNICEF breastfeeding training courses and the eLearning module. Local policies and guidelines were also followed to ensure that information was relevant and accurate for the clinicians in their clinical practice at UHCW. Expert advice was sought from a senior lecturer in midwifery at Coventry University, to ensure the content was accurate.

Table 5 Description of learning content of breastfeeding training courses and the eLearning module

UNICEF In house 1 day Course	UNICEF In house 1 hour update	eLearning Module
Benefits of breastfeeding. Specific benefits for preterm and sick babies	Benefits of breastfeeding. Specific benefits for preterm and sick babies	Benefits of breastfeeding. Specific benefits for preterm and sick babies
Anatomy and physiology of lactation. Physical and emotional action of hormones Maximising Let-down Reflex, Milk production & Milk Transfer	Anatomy and physiology of lactation. Physical and emotional action of hormones Maximising Let-down Reflex, Milk production & Milk Transfer	Anatomy and physiology of lactation. Physical and emotional action of hormones Maximising Let-down Reflex, Milk production & Milk Transfer
Importance of maintenance of a good milk supply. Preventing and managing maternal and common neonatal problems	Importance of maintenance of a good milk supply. Preventing and managing maternal problems	Importance of maintenance of a good milk supply. Preventing and managing maternal problems
Technique for hand and pump expression	Technique for hand and pump expression	Technique for hand and pump expression
<u>Equipment Training</u> Sterilisation, storing and freezing	<u>Equipment Training</u> Sterilisation, storing and freezing	<u>Equipment Training</u> Storing and freezing
Benefits of kangaroo care. Building confidence to support parents.		
Supporting the transition to breastfeeding. Understanding attachment. Recognition of effective attachment.		
Audit results, progress, strengths and weaknesses in our knowledge and skills		

The aims and objectives of the eLearning module focused on both essential knowledge and skills required by clinicians to enable them to support breast milk expression on NICU.

Table 6. Study One aims and learning objectives matched with eLearning content

Aim	Learning Objective	Content
<p>1. To improve knowledge of anatomy and physiology of breastfeeding</p>	<ul style="list-style-type: none"> • To be able to identify anatomic structures of the breast • To be able to describe the physiology of milk production and secretion <ul style="list-style-type: none"> ○ To understand the role of oxytocin ○ To understand the role of prolactin ○ To understand the role of feedback inhibitor of lactation 	<ul style="list-style-type: none"> • Video describing the anatomy and physiology of breast milk expression divided into three sections: <ul style="list-style-type: none"> ○ The role of Oxytocin ○ The role of Prolactin ○ The role of the Feedback inhibitor of lactation • Written information provided outlining the role of colostrum • Diagram of breast anatomy • Diagram of brain anatomy • Diagram of hormone pathway
<p>2. To improve knowledge of breast milk expression by hand and pump</p>	<ul style="list-style-type: none"> • To be able to teach mothers the technique of hand expression • To understand milk volume and how to advise mother what to expect • To be able to give reasons to encourage hand expression • To be able to give advice to mother regarding the frequency of hand expression required • To be able to teach mothers how to use a breast pump • To be able to teach mothers safe storage of breast milk 	<ul style="list-style-type: none"> • Video demonstrating hand expression • Video demonstrating pump expression • Written information on situations in which a breastfeeding mother may find hand expression beneficial and when and how often to hand express • Table of recommended storage temperatures and times • Written information regarding storage and management of expressed breast milk
<p>3. To be able to provide breastfeeding support to mothers on NICU</p>	<ul style="list-style-type: none"> • To be able to identify barriers to successful breast milk expression and suggest strategies to overcome them • To understand: <ul style="list-style-type: none"> ○ The process of relactation ○ How stress affects breast feeding mothers ○ Factors that contribute to the inhibition or delay in milk production in NICU 	<ul style="list-style-type: none"> • Video of mother discussion the difficulties of maintaining a milk supply whilst baby is in intensive care • Table showing causes of low milk supply and action to take • List of journal articles for further reading

Structure

The module was not facilitator led and therefore users were able access the training material at a time convenient to them, learn at their own pace and define personal learning paths based on their individual needs. As far as possible, a learner-centred approach was used to develop the training content. In order to do this it was important to ensure that the learning material was specific to the learner's needs and professional roles, and that it related to real life situations and problems. Once the learning objectives were identified, the course was structured into three sections; each section was designed to achieve each of the three learning aims. The aims were designed hierarchically, in order that learners could build on their knowledge as they worked through the module. Through following this sequence the clinicians would learn the basics of anatomy and physiology of lactation before progressing on to learn about breast milk expression. The instructional, media and delivery strategies are described for each individual aim below.

Design considerations

The module's principal aim was to be used as mandatory training by clinical staff. Like many eLearning modules that are designed for the purpose of mandatory training, there was no facility for interaction between the students and faculty or between the students themselves. It was a stand-alone module and was not part of a curriculum delivered by the university.

The researcher in collaboration with a technical expert in web design, created the course content and an independent expert in breastfeeding education verified educational content. The budget for the production of the module was small, and therefore limited the options available for eLearning design. An education theory specialist leads Coventry University's Centre for Excellence in Learning Enhancement and this department provided full technical support in the development and production of the module. The main site was developed using Adobe Flash and Adobe Photoshop was also used extensively. The finished project was imbedded into an html page and uploaded to Coventry University's Curve Repository.

Creating online training material presents many challenges as well as opportunities for the developer. Clearly, eLearning differs in many ways from face to face learning and it is essential that content is presented in a way that both takes advantage of the unique environment of the online platform whilst ensuring it is effective in its aim. Characteristics of effectively designed webpages identified by Cook and Dupras (2004), include clear and consistent page organization, clear headings, limited lengths of sentences, short phrases and bulleted outlines, limited unused space and few distractions. The technology used in the creation of this eLearning did not require the user to have skills beyond the basic level of computer literacy. The overall layout and design was created to be as intuitive and simple to understand and use as possible, and clear instructions and directions were provided in order that participants could easily navigate the website and access the training. The website provided an email link if learners were experiencing any problems and needed to contact the developer.

The amount of time and availability that clinicians would have to undertake the course was also taken into consideration. The course content was therefore designed with the aim that it could be completed within 30 minutes. In order to access the eLearning content, the user completed the NUCAT assessment and was instructed to click on a hyperlink that took them to the site where the eLearning module was located. Once on this website the total content of the module was spread over three sections that were accessed by links at the top of the web page (Image 1).

Pedagogic considerations

As described in Chapter 3, learning is an inherently complex process and therefore knowledge of compatible learning and teaching styles is essential to the development of course content, teaching approaches, and learning assessments. Learning styles can be defined as 'general tendencies to prefer the process of information in different ways' (Jonassen and Grabowski 2012). In order to maintain learner engagement a mixture of presentation formats were used whilst focusing on keeping instructions clear and simple. Attention was paid to providing

information in an interesting and stimulating way through the use of audio-visual material, whilst also providing written content to ensure a variety of styles were accommodated.

Table 7 describes how associative, constructive and situative approaches to learning were applied to the design of the eLearning module. Constructivist learning has been identified as a key model in the design of on line education because it can support active learning and collaboration among students (Bangert 2004). Constructivist-based teaching supports authentic learning activities that require learners to select, organize, and integrate their own experiences with existing knowledge in order to create new cognitive schema (Hacker and Niederhauser 2000). However, this style of learning is less well suited to didactic course content and is better suited to content that is more facilitative than prescriptive in nature. In order to incorporate authentic learning in this module, short videos were used that contextualised learning either through simulating environments or by showing real life case-based examples to present the information.

Table 7. Study Two defining Approaches to Learning

Perspective	Associated Pedagogy	Instructional Design Principles
Associative	<ul style="list-style-type: none"> • Focus on competences • Clearly stated goals • Provision of feedback • Organised activity 	<ul style="list-style-type: none"> • Learners are tested pre-educational intervention in order to allow them to assess their own learning needs. They are then tested again post intervention to see whether they have achieved their learning outcomes • The module is broken down into instructional units and pre-determining choices exist within the course. • Demonstration videos are used to teach learners the required skills of hand expression and breast pump assembly.
Constructive	<ul style="list-style-type: none"> • Active construction and integration of concepts • Activities that encourage experimentation and discovery of principles • Support for reflection, peer review and evaluation 	<ul style="list-style-type: none"> • The information is presented in a systematic way to build the blocks of basic understanding before application of principles • Learning material (short films) can be watched repeatedly and at the users pace. • The learning module is limited to 30 minutes to prevent cognitive overload • Information is presented as audio visual as well as written in order to appeal to all learning styles • Accompanying log book has a section for reflection
Situative	<ul style="list-style-type: none"> • Participation in social practices of enquiry and learning • Support for development of learning skills 	<ul style="list-style-type: none"> • Real time videos of a mother being taught to express breast milk and use a breast pump contextualises the learning in real practice • Video interview of a mother describing her experiences and difficulties with breast milk expression contextualises the learning in real experience • Further information and resources are identified and listed

Development of content aligned to learning aims

Aim One: To improve knowledge of anatomy and physiology of breastfeeding

A comprehensive understanding of mammary physiology is required for staff to enable mothers to overcome the difficulties inherent in maintaining lactation following preterm delivery, and a lack of education results in conflicting advice and insufficient instruction (Spiby et al. 2009). According to associative learning theory, contextualising information in a setting that is familiar makes it easier for learners to retain information. Therefore, in order to teach the anatomy and physiology of lactation, a short film was created to depict the process of hormonal responses during breastfeeding. This used computer animation to illustrate a baby at the breast whilst the physiological process was shown through an 'inside-out' perspective of the body (Image 1) using 3D animation created using Poser and Adobe After Effects.

Image 1. Screenshot of webpage showing video describing the anatomy and physiology of milk production.

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The working memory includes two partially independent processors the 'visual-spatial sketchpad' and the 'phonological loop' and using one modality may cause it to become overloaded and impair the memorising of information (Young et al. 2014). Therefore, providing educational material in both audio-visual and written format helps to improve retention of information. Further anatomical diagrams of the breast, the brain and a hormone pathway diagram were provided, in order that learners could locate the physiological process being described in the video to the human anatomy.

Aim Two: Improve knowledge of breast milk expression

In order for clinicians to be able to support a mother with hand expression they need to understand how to successfully perform this skill. This section of the eLearning module showed two videos from the Small Wonders DVD produced by the charity Best Beginnings (Image 2). This DVD was produced for parents to provide them with information that could support them during their experience of having a sick baby on NICU (<http://www.bestbeginnings.org.uk/order-small-wonders>). Permission was given by the charity to use two films for the eLearning portal. Each film was around 5 minutes long and showed a nurse specialist teaching a mother to both hand express and use the breast pump. Other information regarding advice that can be given to mothers to support breast milk expression was also provided by a voice-over on the DVD. Further written content was provided that identified key areas of advice to give to a mother along with information on how to store and manage breast milk, including a table (Table 8).

Image 2. Screenshot of webpage showing video of nurse teaching a mother to hand express

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Table 8. Showing Storage of Breast Milk in Hospital or Home (UHCW NHS Trust Local Policy Guidelines)

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Aim Three: To be able to provide breast milk expression support to mothers on NICU

The third and final section of the eLearning module aimed to teach clinicians how to support mothers with breast milk expression. This section included a video that showed a mother being interviewed about her experiences provided breast milk for her sick newborn baby that could be found on the following public information website:

<http://www.healthtalk.org/peoples-experiences/pregnancy-children/breastfeeding/variations-breastfeeding-experience> (Image 3). Permission to use this video for this purpose was sought and approved by both the interviewee in the video and the charity (DIPEX) who own the website.

Image 3. Screenshot of webpage showing video that highlights common problems for mothers expressing milk for babies on the Neonatal Unit

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Further information in this section was given in table format detailing factors that may contribute to the inhibition or delay in milk production (Table 9).

Table 9. Factors that may contribute to the inhibition or delay in milk production

FACTOR	CAUSE	ACTION
Maternal type II diabetes	Insulin plays a part in milk production and can therefore affect ability to produce milk	Important to ensure that blood glucose is well controlled
Thyroid dysfunction	Thyroid hormones aid in the regulation of prolactin and oxytocin	Improving milk release may improve lactation – encourage breast massage and oxytocin stimulation
Early glucocorticoids	May induce premature lactation and lead to lower milk volumes after delivery	Advise and support to ensure successful lactation – encourage frequent expression
Maternal-infant separation	Inadequate stimulation for milk ejection leading to ineffective pumping	Pump cot side, practice Kangaroo care and positive touch and family centred care practices
Stress/fatigue	Inhibition of milk ejection	Stress management and relaxation techniques, listening to music whilst expressing
Breasts not emptied/ Inadequate frequency of pumping	Inadequate removal of milk with breast pump or engorgement Milk stasis – autocrine inhibition (FIL)	Ensure effective emptying of breasts, increase frequency of pumping, double pumping, recording milk output
Nicotine	Smoking mothers may stop breastfeeding sooner than non-smoking mothers or show less inclination to initiate it. This is possibly due to reduction of maternal prolactin levels and decreased milk yield.	Advise mother to reduce or cease smoking and avoid second hand smoke
Alcohol	High intake can completely inhibit milk flow. Milk ejection inhibited by dose-dependent blocking of oxytocin secretion from pituitary in response to suckling. Even small amounts may reduce amount of milk consumed by nursing infants by up to one quarter.	Advise mother to reduce or cease intake

5.2.2 Stage 3 - Testing and refinement

Once the intervention had been designed, developed and implemented, the next stage of design-based research encompassed the evaluation of the proposed solution in practice.

Evaluation of Study One

Aims

Following the development of the first study of the eLearning module, the aims of the evaluation were as follows:

1. To measure the eLearning module's impact on knowledge and confidence on a sample of neonatal clinicians using the NUCAT assessment tool.
2. To evaluate the NUCAT assessment questions through item analysis
3. To measure the eLearning module's usability through survey questions built into NUCAT
4. To explore clinicians' experience of using the eLearning module and NUCAT assessment tool through semi-structured interviews.

Aim 1

To measure the eLearning module's impact on the knowledge and confidence on a sample of N = 11 neonatal unit clinicians using the NUCAT assessment tool

Descriptives

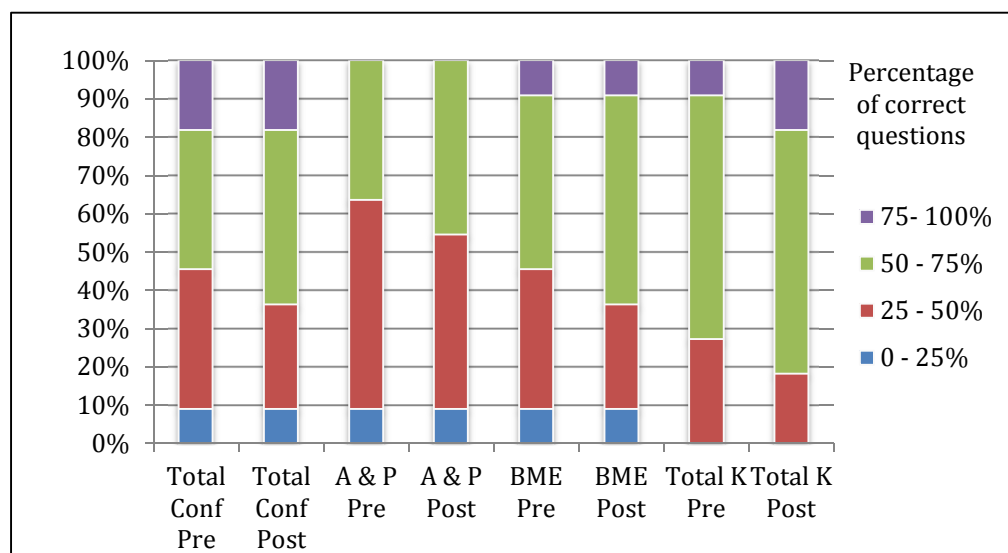
The first formal evaluation of the eLearning intervention was conducted in March 2013. In total, a convenience sample of 11 clinicians from UHCW completed the eLearning module and NUCAT assessment. For further information regarding selection and recruitment see Chapter Four Section 9.2. All participants were female neonatal nurses who spent >75% of their working week in clinical care. Around half of them had not received breastfeeding training for over 2 year (n=6) whilst the rest had received training within the last two years

(n=5). Most had worked in NICU for over 5 years (n=8) and were aged between 20 and 39 years (n=7) or 39-59 (n=4).

Results

Figure 9 presents the pre and post intervention test data as the proportion of clinicians who scored in each quartile, pre and post intervention. This shows a slight improvement in knowledge and confidence scores post intervention. Further testing was undertaken using the paired-samples t-test to determine whether the mean difference between the paired observations was statistically significantly different from zero (Table 10). No statistically significant differences were found between the mean pre and post intervention scores suggesting that the intervention was not effective in its aim of improving knowledge or confidence.

Figure 10. Results Study One percentage of participants with correct scores for anatomy and physiology, breast milk expression and total knowledge



Legend

Pre = pre intervention
 Post = post intervention
 A and P = Anatomy and Physiology score
 BME = Breast Milk Expression score
 Total K = Total Knowledge
 Total Conf = Total Confidence

Table 10. Results from Study One t-Tests

Pre and Post Test Subject	Pre- Intervention mean score (SD)	Post- Intervention mean score (SD)	<i>p</i> value
Total Confidence (1-60, ↑ = more confidence)	35.73 (10.74)	37.82 (11.31)	<i>p</i> = 0.13
Total Knowledge (1-20, ↑ = more knowledge)	12.00 (2.61)	13.18 (2.36)	<i>p</i> = 0.06
Knowledge in A and P (1-10, ↑ = more knowledge)	4.45 (1.04)	5.36 (1.63)	<i>p</i> = 0.03
Knowledge Breast Milk Expression (1-10, ↑ = more knowledge)	7.55 (1.92)	7.82 (1.33)	<i>p</i> = 0.61

Whilst these results suggested that improvements in the eLearning module may be required, further analysis was necessary in order to identify specific aspects that required targeting. Further evaluation was therefore undertaken in order to explore these findings and isolate the root cause for a lack in knowledge improvement.

Aim 2

To evaluate the NUCAT assessment questions through question item analysis

In order to ensure that the content was relevant to the learning outcomes, as measured by the NUCAT assessment, data was collected and simple item analysis (looking at the participants scores for each question) was undertaken. Question analysis was also performed in order to eliminate ambiguous or misleading items and identify specific areas of course

content that may need greater emphasis or clarity. A table was created to match NUCAT questions to the eLearning content, in order to ensure that the eLearning module provided the necessary information to enable the learner to answer the question (Table 11). From this information it was possible to identify areas where the course content may need to be altered. This could then inform the next iteration of both the design of the eLearning module and the NUCAT assessment.

In order to measure item difficulty and identify those questions that may be either too easy or too hard, it was necessary to measure the percentage of learners that answered each question correctly (Table 11). Questions answered correctly by over 85% of participants could be considered too easy, and by less than 50% too difficult, leaving the desired range between 51-84% and the ideal difficulty level of 74%.

Table 11. Study One pre and post intervention question responses

Item Number	Question	Correct on Pre Test (total n=11)	Correct on Post Test (total n=11)
Q01	Which of the following hormones governs the production of milk components?	8 (72%)	8 (72%)
Q04	Which of the following can inhibit the milk ejection reflex	5 (45%)	11 (100%)
Q05	What happens if milk is not removed from the breast?	9 (81%)	11 (100%)
Q06	According to autocrine theory what is FIL (feedback inhibitor of lactation)	1 (10%)	5 (45%)
Q07	According to autocrine theory, where is FIL thought to exist?	3 (27%)	5 (45%)
Q08	What is the action of the Feedback Inhibitor of Lactation?	4 (36%)	5 (45%)
Q09	Which of the following factors is known to influence the composition of breast milk at birth?	8 (72%)	10 (90%)
Q10	How does the composition of milk vary in the breast during a typical feed?	4 (36%)	4 (36%)
Q12	Human colostrum is particularly rich in which of the following vitamins?	2 (18%)	3 (27%)
Q13	If a preterm baby is not growing well despite indications that they have enough protein and mother has plenty of milk, what are the first steps you could take to increase energy intake?	3 (27%)	3 (27%)
Q14	Why should mothers whose babies are too young, or too ill to breastfeed, start expressing by hand instead of by breast pump?	11 (100%)	11 (100%)
Q16	Ideally, how soon after she has had her baby should a mother of a baby unable to breastfeed be encouraged to express milk?	11 (100%)	11 (100%)
Q18	What is happening in this clip below?	7 (63%)	8 (72%)
Q19	How is milk removed during hand expression?	10 (90%)	8 (72%)
Q21	To maximize breast milk production, when should a mum move from hand expressing onto the pump?	7 (63%)	8 (72%)
Q22	When a mother is establishing breast milk production, how often should she express in a 24-hour period?	8 (72%)	11 (100%)
Q24	What are the benefits of double pumping?	4 (36%)	5 (45%)
Q27	What volume of milk should a mother be expressing per day-by-day 6 or 7, as an indicator of a good milk supply?	8 (72%)	8 (72%)
Q31	What is the recommendation regarding the storage of breast milk in a domestic freezer?	4 (36%)	5 (45%)
Q33	What is the safest method of defrosting expressed breast milk that has been frozen?	9 (81%)	9 (81%)

The aim of the analysis was to discover how undertaking the eLearning intervention affected participant scores. The most marked increase in numbers scoring correctly post intervention was for Q04 (45%-100%). This was important for two reasons, firstly it supported the argument that clinicians lacked knowledge in the anatomy and physiology of lactation and secondly it suggested the training was effective in its aim. However, for a majority of questions the improvement was either very minor, showing an increase of only one participant scoring correctly post intervention (Q07, Q08, Q12, Q18, Q21, Q24, Q31), or showing no improvement at all (Q01, Q10, Q13, Q14, Q16, Q27, Q33). One question (Q19) showed a fall in the numbers scoring correctly from 90% to 72%.

To further explore the reasons why participants' scores did not improve significantly following the intervention, question items were mapped to the content in the eLearning intervention (Table 12). This exercise helped to clarify exactly what material was given to the learner in order to highlight any areas where the eLearning had failed to provide adequate information. As a result of combining the information from Table 11 and Table 12 it was possible to locate potential areas in which both the NUCAT assessment and the eLearning could be improved.

Table 12. Study one NUCAT question item with eLearning extract

<u>ITEM</u>	<u>QUESTION</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY ONE</u>	<u>SUBSTITUTE ITEM FOR STUDY TWO</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY TWO</u>
1.	Q01 Which of the following hormones governs the production of milk components?	A & P	Prolactin	'The level of prolactin in the blood remains high up to one and a half hours after the feed; thus sucking at one feed helps stimulate production of the milk for the next.' Coventry University Video				
2.	Q04 Which of the following can inhibit the milk ejection reflex?	A & P	Stress	'The let down reflex may be affected by stress and cause milk flow to slow or stop flowing.' Coventry University Video				
3.	Q05 What happens if milk is not removed from the breast?	A & P	Milk production diminishes	'When the breast is not emptied, FIL remains in contact with the alveolar cells and this inhibits the secretion of milk constituents. This appears to be the mechanism of decreased milk production due to not emptying the breast.' Coventry University Video				
4.	Q06 According to autocrine theory what is FIL (feedback inhibitor of lactation)	A & P	A milk Protein	'A recently described milk protein FIL seems to play an important role in the continuation of milk supply.' Coventry University Video				

<u>ITEM</u>	<u>QUESTION</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY ONE</u>	<u>SUBSTITUTE ITEM FOR STUDY TWO</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY TWO</u>
5.	Q07 According to autocrine theory, where is FIL thought to exist?	A & P	Within the milk	'Fil acts locally within each breast and is secreted into breast milk.' Coventry University Video				
6.	Q08 What is the action of the Feedback Inhibitor of Lactation?	A & P	It inhibits the synthesis of milk constituents	'It inhibits the synthesis of milk constituents through a feedback mechanism.' Coventry University Video				
7.	Q09 Which of the following factors is known to influence the composition of breast milk at birth?	A & P	Gestation of the baby	If the baby is born prematurely the mammary gland works overtime to produce milk with higher concentrations of components that should have come from the placenta. Written Text	Q03 Which of the following is not a sign of the milk ejection reflex?	A & P	Feeling cooler	'A mother may feel some tingling or uterine contractions when she is expressing milk.' Coventry University Video
8.	Q10 How does the composition of milk vary in the breast during a typical feed?	A & P	High volume, low-calorie milk gradually changing to low volume, high-calorie milk	'The later milk is richer and higher in fat.' Small Wonders Video				
9.	Q12 Human colostrum is particularly rich in which of the following vitamins?	A & P	Vitamins A and K	Colostrum contains all the nutrients and protective factors of mature milk in higher concentrations and is very rich in proteins, vitamin A and K, and sodium chloride, but contains lower amounts of carbohydrates, lipids, and potassium. Written Text				

<u>ITEM</u>	<u>QUESTION</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY ONE</u>	<u>SUBSTITUTE ITEM FOR STUDY TWO</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY TWO</u>
10.	Q13 If a preterm baby is not growing well despite indications that they have enough protein and mother has plenty of milk, what are the first steps you could take to increase energy intake?	A & P	Separate off hind milk from each expression and feed that to the baby preferentially	No specific content identified	Q11 Which of the following breastmilk components promotes gut acidity, therefore preventing bacterial growth?	A & P	Bifidus Factor	'Human milk contains bifidus factor which encourages the growth of lactobacillus bifidus, this creates an acidic environment in the gut.' Coventry University Video
11.	Q1014 Why should mothers whose babies are too young, or too ill to breastfeed, start expressing by hand instead of by breast pump?	Breast milk expression	It helps to stimulate breastmilk production if the baby cannot feed at the breast	Written Text	Q26 To maintain breastmilk production, which one of the following is the most important for mothers of premature and sick infants? Colostrum?	Breast milk expression	Continual and effective expression of breastmilk	'Continual and effective expression is the most important factor in maintaining a good milk supply when a mum cannot breastfeed.' Coventry University Video
12.	Q16 Ideally, how soon after she has had her baby should a mother of a baby unable to breastfeed be encouraged to express milk?	Breast milk expression	Within 6 hours	'Mothers should be encouraged to express within 4-6 hours of birth' Small Wonders Video				
13.	Q18 What is happening in this clip below?	Breast milk expression	Breast massage	Film footage of a mother hand expressing Small Wonders Video	Q25 What is the best course of action if an expressing mother is not producing colostrum	Breast milk expression	Check her hand expressing technique	'A mother may require support with hand expressing so it is important to check her technique is she is having difficulties.' Coventry University Video
14.	Q19 How is milk removed during hand expression?	Breast milk expression	Compression of the ducts	'All that is needed to remove milk is gentle compression' Small Wonders Video				

<u>ITEM</u>	<u>QUESTION</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY ONE</u>	<u>SUBSTITUTE ITEM FOR STUDY TWO</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY TWO</u>
15.	Q21 To maximize breast milk production, when should a mum move from hand expressing onto the pump?	Breast milk expression	When 10ml can be expressed at a time	A mother can move on to the breast pump once she is hand expressing around 10mls each time Written Text				
16.	Q22 When a mother is establishing breast milk production, how often should she express in a 24-hour period?	Breast milk expression	8-10 times	Express 8 -10 time in 24 hours Written Text				
17.	Q24 What are the benefits of double pumping?	Breast milk expression	Increases fat content and volume of milk	Increases milk supply and fat content. Small Wonders Video	Q30 What is the longest time expressed breast milk can be safely stored in a refrigerator between 2-4°C	Breast milk expression	Up to 48 hours	Fresh EBM can be stored at room temperature for up to 4 hours or in a suitable fridge for up to 48 hours. Coventry University Video
18.	Q27 What volume of milk should a mother be expressing per day-by-day 6 or 7, as an indicator of a good milk supply?	Breast milk expression	500mls	Around 500mls in 24 hours Written Text				
19.	Q31 What is the recommendation regarding the storage of breastmilk in a domestic freezer?	Breast milk expression	Up to 6 months	Up to 6 months Written Text				
20.	Q33 What is the safest method of defrosting expressed breast milk that has been frozen?	Breast milk expression	In a fridge	Frozen milk can be left to defrost slowly by leaving it in a refrigerator. Written Text				

Whilst the eLearning intervention appeared to make only a small improvement in knowledge, it was important not to disregard the effectiveness of the NUCAT assessment questions as this may have been explained by other reasons. Although questions Q01, Q10, Q13, Q14, Q16, Q27, Q33 showed no improvement in knowledge, this pilot used a small number of clinicians who were all fairly experienced neonatal nurses and therefore may have had reasonable baseline knowledge already. There were also a finite number of questions in the NUCAT question pool so it was also important to consider which questions represented the most key areas of knowledge, such as understanding the principles behind breast milk production. Therefore these were retained despite the question showing limited or no improvement during the first pilot study. Table 12 details all the question items and their corresponding eLearning content and then identifies the question items that were replaced for study two of the pilot, along with their corresponding educational content. In total five questions were identified as being unsuited to study two of the pilot study. The reasons for this are outlined in Table 13.

Table 13. Study One question items identified for replacement in study two

Item number	Question	Reason for Replacement
Q09	Which of the following factors is known to influence the composition of breast milk at birth?	Staff had a good baseline knowledge of this question and it was not a good measurement of the learning outcomes
Q13	If a preterm baby is not growing well despite indications that they have enough protein and mother has plenty of milk, what are the first steps you could take to increase energy intake?	The eLearning module did not provide adequate specific information and this question was not well suited to the learning outcomes
Q14	Why should mothers whose babies are too young, or too ill to breastfeed, start expressing by hand instead of by breast pump?	This question scored 100% pre and post intervention and did not appear to be a good measure of learning outcomes
Q18	What is happening in this clip below?	This question was removed due to technical difficulties with access to video footage
Q24	What are the benefits of double pumping?	This question showed marginal improvement and several questions relating to pumping already included therefore it was replaced with a question regarding storage

The NUCAT assessment used a four-item response multiple-choice format, thereby giving a one in four chance of answering the question correctly. Advantages of multiple-choice questionnaires include objective, rapid scoring and improved reliability on true-false test items. However, Cohen et al. (2013) note that one limitation of the multiple-choice questionnaire is that words are inherently ambiguous and respondents may interpret them differently, thereby rendering the data ambiguous. A further limitation is that multiple-choice tests operate on the assumption that there is only one correct answer, whereas learners may feel strongly that this isn't the case. In order to give respondents the opportunity to comment on the individual questions used in NUCAT, and thereby highlight concerns with question wording, each question item was provided with a free text box (Table 14).

In Study One, responses were only provided for two questions. The response to Q18 relates to the format in which the question was delivered. In this case NUCAT showed a clip from a video and the participant was asked to view the clip and answer the question. Technical issues prevented them from being able to watch the film footage. As a result of this it was decided that film clips would not be used with the NUCAT assessment and the question was therefore replaced with another item. The response to Q 13 describes an alternative answer to the one provided in NUCAT. This is interesting information as it provides an insight into the existing knowledge of staff and can also expose misconceptions that further justify the need for training.

Table 14. Study One Free text responses to individual NUCAT item questions

Item Number	Question	Answer	Participant comment
Q 13	If a preterm baby is not growing well despite indications that he/she is getting enough protein and mother has plenty of milk, what are the first steps you could take to increase energy intake?	Separate off hind milk from each expression and feed that to the baby preferentially	<ul style="list-style-type: none"> I would also advise mother to eat a higher calorie diet, as well as eat a healthy, well balance
Q18	What is happening in this clip below	Film footage of a mother hand expressing	<ul style="list-style-type: none"> Unable to view the video. Cannot view video. Unable to upload video. Downloaded application. And waited for video to load but it didn't. There are no blocks on my computer. Sorry unable to answer this question

Aim 3

To measure the eLearning module's usability through survey questions built into NUCAT

Usability

ELearning interventions combine instructional design with technological delivery. In order to be used effectively the learner must understand how to interact with the product in order to achieve the specified intended learning outcomes (Sandars 2010). As such, usability testing is integral to the success of an intervention as it can provide a useful approach to understanding and overcoming the barriers to effective learning, and thereby inform product development. However, despite this, usability testing in eLearning, and especially medical education, is rarely described (Sandars 2010).

Four main dimensions for usability testing of eLearning have been identified (Sandars and Lafferty 2010): the learner, technological aspects, instructional design aspects and the

context. Careful consideration of the learner's needs and motivation are required, and in particular their competence and confidence with using technology. Technological aspects are concerned with the ease with which the user is able to interact with the learning material and find specific items of content via menus or indexes, and follow instructions or commands. The context in which the learning will take place is also important as computers may require audio facilities and an efficient web connection in order to access the learning materials.

Prior to undertaking the pilot study the eLearning module was user-tested by Coventry University staff working in the research department, who knew nothing about the design of the intervention, in order that they could identify any concerns with instructions and ensure the website was user friendly. The researcher was present throughout these sessions in order to record problems that arose during testing. This session highlighted some issues with written instructions that led the user through the website, changes were made accordingly and the eLearning module was then ready to be user tested by neonatal clinicians.

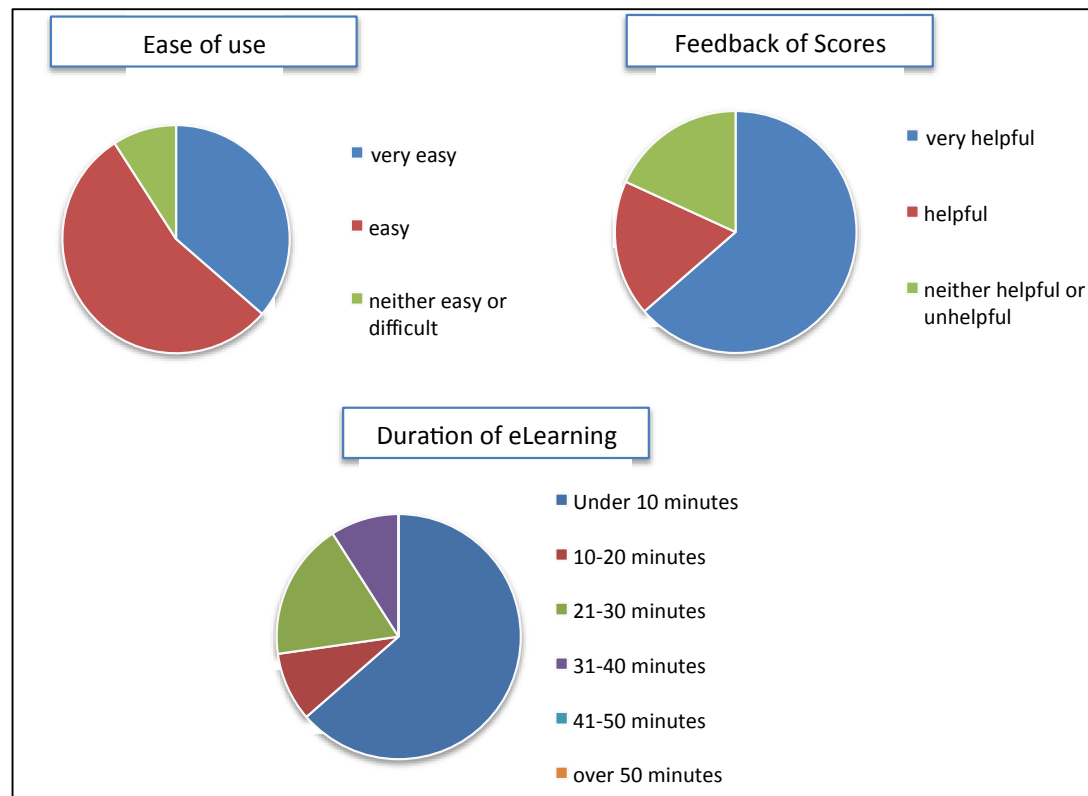
The following usability questions were asked of the participants following completion of the eLearning module and NUCAT assessment:

1. How would you rate the ease of use of the NUCAT e portal?
2. How long in minutes did it take you to complete the NUCAT eLearning module approximately (exclude any time taking breaks)?
3. How helpful was it to have the feedback of your percentage scores at the end of the NUCAT assessment?

Figure 11 illustrates the responses to these questions using pie charts. Almost all users found the eLearning and website either easy or very easy to use, despite the concerns with being unable to access one of the NUCAT questions. A majority found the feedback of NUCAT scores helpful. The most interesting aspect of these results is the time that was spent undertaking the eLearning, which a majority of the learners completed in under 10 minutes.

This suggests that learners may have rushed through the written content and perhaps not read it thoroughly enough to understand the information and process it.

Figure 11. Study One pie charts illustrating the participant responses to the survey questions



Free text boxes were provided at the end of the training session that asked the following questions:

1. Which aspects of the eLearning module did you find most useful?
2. In what ways do you think the eLearning module could be improved?

Participant comments added some depth to the quantitative findings. Positive statements about the content of the module focused on the relevance and availability of the information. Negative comments were primarily related to initial problems accessing the website or that adversely affected students learning, the most significant of which being sound quality

Aim 4

To explore clinicians' experience of using the eLearning module and assessment tool through semi-structured interviews.

Interviews were undertaken with participants who had completed version one of the eLearning module and NUCAT assessment. From this group (n=11), clinicians were invited to take part in interviews to explore their experience of using NUCAT and the eLearning. In total 5 participants agreed to take part in interviews, all were neonatal nurses who had range of NICU experience from 2 to 13 years. Chapter Four describes the methods used in both the recruitment of participants and the analysis of data. The interviews focused on the usability of the website and eLearning module and NUCAT assessment.

Interview Results

Table 15 Study One Interview Themes

A Priori Themes	Emerging Themes
Experience of undertaking the eLearning module	Anatomy and Physiology content difficult Suitable for the multidisciplinary team Enjoyed the video content Technical difficulties Flexibility of eLearning
Experience of undertaking the NUCAT assessment	Helped to identify learning needs

It was important to ascertain whether clinicians felt that the eLearning content was both relevant and accessible. Positive responses related to the how helpful it was to use the training material in conjunction with the NUCAT assessment as questions helped to sign post important learning points:

I remember thinking, "It's all very informative and stuff that I didn't know," and after doing the questions I'm thinking, "Oh, yeah." It made sense to the questions and

you could pick up where I'd gone wrong. So it did help. (Staff Nurse, 2 years experience)

'Anatomy and physiology content difficult'

However, there were concerns that the anatomy and physiology content was too difficult to be taught directly to mothers. It was felt that it was important knowledge for clinicians to have but highlighted the necessity of conveying this information to the mother in layman's terms:

At some points it was too advanced for what we would give to mums. I think its fine having the basic; you know you always need the basic knowledge about the feedback systems and everything. But when it started saying about what cells the milk produced, and you wouldn't use that with the mums so it tends to be information that you've got tucked away in your brain somewhere but don't use it frequently. So quite a high level of information. (Sister, 9 years)

Some of them were quite difficult to answer, more on the physiological side of it because we don't tend to go into that with the parents. It's an area we wouldn't necessarily read up on. (Sister, 13 years)

'Suitable for the multidisciplinary team'

When clinicians were asked how they felt about the knowledge being tested they all agreed that the multidisciplinary team should be offered the training:

I think all... definitely, including the doctors, I think, should be educated on it, because they don't have an understanding of why it takes maybe longer to get babies feeding. (Sister, 13 years)

I think everybody should. I don't think they think it's their role, but I do think it would benefit them as well, 'cause I think as a whole healthcare profession it should be overall, everybody, not just nurses or nursery nurses. It should be the whole, multi-disciplinary team as well. (Staff Nurse, 6 years)

'Helped to identify learning needs'

It was recognised that the NUCAT assessment was a useful tool to motivate clinicians as it helped to identify learning need and thereby impress upon them the importance of undertaking the training. The level of difficulty was an issue for some and again they highlighted that the physiology section was more challenging:

It did make me realise that I needed to do more training, so it was of benefit because it made me realise how much I did know, and what I didn't know, (Sister, 13 years)

Well it was kind of a good indicator of how well you did, I of think it's surprising sometimes you think oh my goodness I didn't do as well as I expected to have done. (Sister, 9 years)

They were quite difficult, but I felt like they were things I probably should have known, and didn't know. (Staff Nurse, 2 years experience)

'Enjoyed the video content'

Importantly, participants were very positive about the videos that were used in the module and particularly liked the ease with which they could control the pace of learning by repeating them as necessary:

I liked the video clips. They were really helpful and a lot of the information. From what I remember, I found all three of them really interesting. I'd have quite liked to have that little video just to watch over and over again, because it was really good. (Staff Nurse, 2 years experience)

And to have like a link you could just go to, I think it would be really helpful. And a bit more, I don't know, interesting than picking up a book. Having like a little video, and stuff. (Staff Nurse, 2 years experience)

One participant described a need for the inclusion of further video footage for the next iteration and talked of using more interesting imagery to illustrate the training content:

It could be a bit more of videos, I think. Or maybe more colourful pictures, you know, with the breast and the veins and, you know all the ducts, and things. (Staff Nurse, 6 years)

'Technical difficulties'

Only one participant described difficulties with accessing the video content. However, a further issue that was highlighted was the lack of organised study time in which the participants could undertake the training. As a result some felt that they had been rushed which is an important point because it is quite likely that this may have affected their scores:

I do feel like I rushed through it quite a lot and was trying to get through it quite quickly, when I was doing it. (Staff Nurse, 2 years experience)

I think, like I say, because it was... I was at work, I was rushing it, I think. (Staff nurse, 8 years)

'Flexibility of eLearning'

The flexibility of being able to do eLearning outside of work hours appealed to a number of participants who said that they would almost prefer to do it in their own time due to the difficulties of finding time to fit this in at work:

I think it's good because you can do it in your own time, because you don't get time to do it at work. You can do it at home. Because you can do it in the peace of your own home, when you've got time to do it. I think it would be better, because at work it's just so busy, you don't tend to get the time to actually sit and concentrate on what you're doing. (Sister, 13 years)

Because all you need is like a username and password, and you can do it in your own time. You don't have to do it at work. You can do it at home. We never have time at work to even check your e-mails, but at home... I mean, I did it, when you sent it to me, I did it at home so it was easy just to access it and just sit in my own zone, really, and do it without doing it at work with alarms going off, and people being

called to do drugs, and things. So online learning, definitely, was very helpful. I prefer eLearning. (Staff Nurse, 6 years)

I think it gives all staff members whatever shift pattern they are on, the opportunity to do it at work. So you can get people that do permanent nights and people that only work weekends or those people that work Monday to Friday, I think you can access all areas (Sister, 9 year)

Clinicians would not normally be expected to complete mandatory training in their own time but were asked to undertake this training in their own time because it was part of this study. However, these comments highlight an interesting point, that some clinicians would welcome the chance to undertake further training in their own time in order to improve their skills and knowledge.

5.2.3 Stage 4 - Practical Redesign Steps Taken

The empirical data collected during the formative evaluation provided suggestions for improving the intervention. Overall, the response from the first pilot study was encouraging, however it also highlighted difficulties with accessing this particular module and identified several areas that required further development. Both comments left on the NUCAT website and interviews with participants identified technical issues concerning the ability to both log on to the web site through hospital Trust portals, and stream videos within the NUCAT questionnaire. As a result of this, some participants were unable to either answer questions correctly or access training material. It was also noted that the time taken to undertake the eLearning was very brief, with 7 of the users completing it in less than 10 minutes. This was concerning because this version of the eLearning module used three short videos that would have taken around 10 minutes to watch in total, suggesting that users did not spend time reading the written the information. Interviews indicated that some users they felt rushed when undertaking the eLearning, and this could be as a result of having to do it whilst at work. Unfortunately, during this study it was not possible to organise for users to take part in

the research in protected study time and therefore opportunities to access the training were limited to either personal time or whilst on duty.

During this period of data collection, time was also spent attending staff meetings and discussing breastfeeding issues on the NICU that could further inform the content of the module. This brought to light information that could be used to inform the second development of the intervention. Firstly, whilst staff agreed that this was a challenging environment for mothers to be successful at breastfeeding, they were not aware of the national and local breastfeeding rates at discharge. It is known that motivation can be strongly influenced by both the educational environment and the learner's frame of mind towards learning (Ten Cate 2011). Therefore, in order provide context to the eLearning and encourage staff interest in a subject where there is clear need for improvement, national and local breastfeeding rates at discharge were presented during the introduction to the next iteration of the eLearning module.

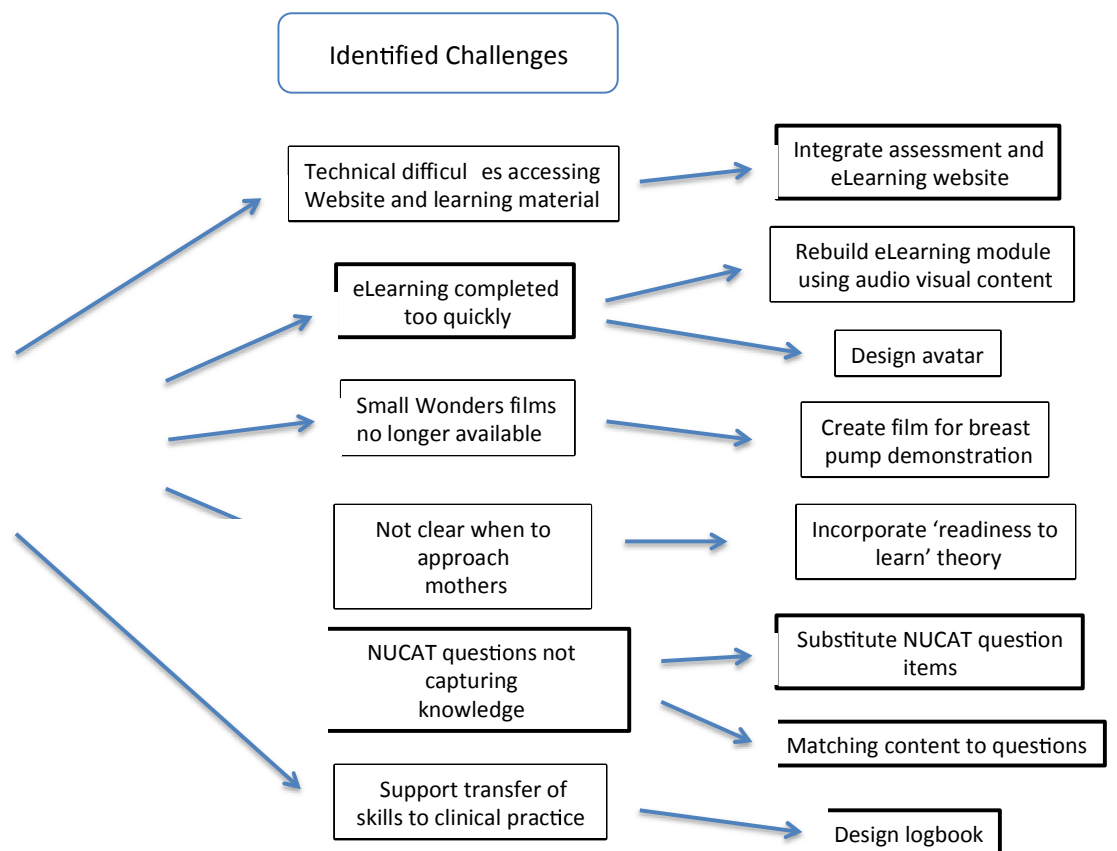
Wallace et al. (2013) highlighted a lack of clinician awareness of the benefits of breast milk and this was further substantiated when discussing breastfeeding training with staff on NICU. Some staff also lacked confidence in approaching mothers who had very sick infants to discuss initiating breast milk expression. It was therefore decided that the second iteration of eLearning should include further information that related to approaching mothers to discuss breast milk expression, including the benefits of breast milk, in order to further contextualise the knowledge provided in the module to support a mum to breast milk expression, and enable clinicians to apply it in practice. To accompany this information and support clinical practice aligned to the eLearning module, a logbook was designed that could be used to both provide information in a written format and also provide areas for personal reflection and assessment of skills.

The technical issues experience by users in the first iteration probably arose through difficulties with the hospital Trust instituting intentional barriers such as firewalls to ensure

security and resilience of technical systems. In order to overcome this problem the second iteration of eLearning was therefore designed to run from one html platform from which the user could access both the assessment and the training.

As a result of users only taking on average of around 10 minutes to complete the eLearning and also requesting for more audiovisual teaching, the eLearning was completely redesigned. Firstly, the aesthetics of the homepage and contents page were modified and improved, including the text colour and size. It was decided that short videos, in the form of 'learning nuggets', that were less text intensive and more visual should be developed. It was hoped that this method of content delivery would both encourage learners to take the time to absorb the information being delivered, as they would be required to sit and listen to the content, and make it a more interesting and enjoyable learning experience. Learning nuggets are short learning segments that focus on a single topic and are no longer than 5 to 8 minutes (Wood 2010). As such, each short film could be completed individually and allow the user to decide which particular areas of learning they wish to focus on, whilst giving them the control to watch each film as many times as they wish. This would also result in the users having to watch the video and listen to the learning content whilst key aspects of the text were being shown rather than simply read text on its own. However, it was important to ensure that the module could be completed within 30 minutes; therefore each film (eight in total) was timed to ensure that it could be watched and the information on the screen could be read within this time frame.

It was decided that an avatar would be used to deliver the educational information in the films. The researcher and CELE team designed a breastfeeding Russian doll who could move her head and eyes whilst speaking to represent the instructor and provide a fun role model for breastfeeding. Advantages of using avatars is that they can be considered interesting and appealing, are easy to produce and allow faster development than video clips (Wood 2010). However, disadvantages include the need for expensive software to produced them and the fact that they can be found to be irritating by some users. The entire content of the



5.3.1 Stage 2 – Study Two

Second iteration in the development of prototype solution –

eLearning Module (Version 2)

Learning aims and objectives

The outcomes of the evaluation of the first iteration of the eLearning were used to inform the second iteration of development. The learning aims and objectives outlined in Table 16 below underwent minor changes to include the benefits of breast milk feeding. Further changes to content were made in order to improve the learner's ability to achieve the learning aims and these will be described in more detail under the individual aims section.

Table 16. Study Two aims and learning objectives matched with eLearning content

<i>Aim</i>	<i>Learning Objective</i>	<i>Content</i>
1. To improve knowledge of anatomy and physiology of breastfeeding	<ul style="list-style-type: none">• To be able to identify anatomic structures of the breast• To be able to describe the physiology of milk production and secretion<ul style="list-style-type: none">○ To understand the role of oxytocin○ To understand the role of prolactin○ To understand the role of feedback inhibitor of lactation	<ul style="list-style-type: none">• Animated film describing the anatomy and physiology of breast milk expression divided into three sections:<ul style="list-style-type: none">○ The role of Oxytocin○ The role of Prolactin○ The role of the Feedback inhibitor of lactation
2. To improve knowledge of the benefits of breastfeeding	<ul style="list-style-type: none">• To be able to identify the benefits of breastfeeding to both infants and mothers• To be aware of the specific benefits of human milk for premature infants	<ul style="list-style-type: none">• Animated film providing information on the benefits of breastfeeding
3. To improve knowledge of breast milk expression by hand and pump	<ul style="list-style-type: none">• To have knowledge of local breastfeeding initiation and duration rates• To understand the benefits of breastfeeding• To be able to teach mothers the technique of hand expression• To be able to teach mothers	<ul style="list-style-type: none">• Introductory film presenting local and national breastfeeding rates at discharge from NICU• Animated film providing information on the benefits of breastfeeding• Animated film discussing hand and pump breast milk expression• Short video demonstrating assembling a breast pump• Short video demonstrating hand expression

	how to use a breast pump <ul style="list-style-type: none"> • To be able to counsel mothers about milk storage • To be able to teach mothers safe storage of breast milk 	technique <ul style="list-style-type: none"> • Log book detailing all information in the eLearning and a list of referenced articles available to download from the website • Table of recommended storage temperatures and times
4. To support breast milk expression	<ul style="list-style-type: none"> • To be able to counsel mothers about establishing and maintaining breastfeeding during separation from the infant • To be able to identify barriers to successful breast milk expression and suggest strategies to overcome them • To understand the experience of mothers who express milk on NICU 	<ul style="list-style-type: none"> • Animated film describing how to approach mothers to discuss initiation of breastfeeding – ‘readiness to learn’ • Animated film describing common difficulties experienced by mothers expressing and detailing advice to be given • Animated film using avatars to quote research interviews with mothers regarding their experience of breastfeeding on NICU • Table identifying common barriers to successful breast milk expression and action to take • Log book detailing all information in the eLearning and a list of referenced articles available to download from the website

Structure

The hierarchically structured aims from study one were retained for study two. The module content was redesigned and divided into eight sections:

1. The benefits of breastfeeding
2. Mother’s experience of providing breast milk for her baby on NICU
3. The anatomy and physiology of lactation
4. Hand Expression
5. Breast pump expression
6. Storage of breast milk
7. Common difficulties and trouble shooting
8. Conclusion

In order to give the learner the opportunity to go over information repeatedly, all teaching sections were delivered in short animated films (lasting between 2 and 4 minutes). The ability to pause information and re-listen to it enabled the learner to control the pace at which they were being taught and revisit material that they may not have understood on their first encounter with it. After completing the eLearning and post intervention NUCAT assessment a

certificate was available for the learner to download. They were informed that this certificate along with any information recorded in their logbook could be used to contribute towards their Nursing and Midwifery Council (NMC) (2011) PREP requirements that are necessary for their continued professional registration.

Design considerations

For the second e-Learning module, the site was built using i-Web. Characters were designed using Poser and Photoshop. These were then animated using Crazytalk, and finally edited together with titles in Final Cut Pro. Additional 3D animations were created in Blender. After Effects was also used for some animations. All Audio was recorded using a Zoom recorder and edited in Audacity. Garageband was also used to further enhance the audio. The completed html pages were uploaded into the Coventry University Curve Repository.

Due to the technical problems experienced in the first iteration of the design, the eLearning content and the NUCAT assessment were built on the same website for this iteration. As such, the user did not have to leave the NUCAT website and was able to navigate to the training page, via a hyperlink, once they had completed the pre intervention assessment. On completion of the training they were then navigated back to the NUCAT assessment by the same method. Once on the eLearning site, the training content was accessed through a list of headings on the left side of the main screen. Each of the headings could be clicked on and that section of training would then play in the main screen (Image 4).

Image 4.

Screenshot of webpage showing

layout of training module

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Pedagogic considerations

For the second iteration of the eLearning further consideration was given to the motivational aspects of learning in order to ensure learners felt engaged with the content. Because not all adults are equally intrinsically motivated, the eLearning module content employed motivational techniques to encourage learners. Kelly (2006) identified six factors that motivate adult learners: attitude, need, stimulation, affect, competence, and reinforcement. In order to ensure the learners understood the need to undertake the training the local and national breastfeeding rates at discharge were included in the introduction to the module. Because local figures are below the national average, this indicated the need for improvement in local practice. Information regarding the benefits of breastfeeding was also included to highlight the importance of this training and ensure that staff understood the impact of breastfeeding on morbidity and mortality in this vulnerable group of babies. To further help motivate the learner and increase their confidence in approaching mothers to discuss breast milk expression advice, was provided on how to approach a mother to discuss breastfeeding.

Whilst the eLearning equipped staff with the knowledge and skills to teach a mother how to express milk by hand and by using the breast pump, for staff to develop self-efficacy they must progress from theoretically understanding the principles to developing the skills in practice. Kolb's (1984) experiential learning theory describes the process of applying knowledge as consisting of four steps, sometimes referred to as sensing/feeling, watching/reflecting, thinking, and doing. The cycle can be entered at any point but should be followed in sequence. These four stages show how experience can be translated through feedback and reflection into concepts, which can then guide future experimentation and the consequences of that action. Learners should go through the cycle several times in order to utilise the learning aspects of each round.

A module logbook was provided for the learner to download on completion of the eLearning. This provided learners with information provided in the eLearning and ensured that those

who preferred to learn by reading from hard copy could do so. This logbook also enabled the learner to explore the option of writing their own experiences of how they had benefitted from the training and applied it in practice, thereby following Kolb's principle. The logbook also provided an assessment proforma that could be used to evaluate them teaching a mother to express breast milk whilst in clinical practice. For the final, evaluative study, the repeat of a post intervention assessment of confidence at 6-8 weeks was designed to capture any change in confidence as a result of both the education and the opportunity to undertake the practice on the NICU.

Because the design of this eLearning module used audio-visual animated films to present information, caution was taken not to visually overload the learner by ensuring that the information that was presented on screen was not too dense and that they had enough time to read it. Graphics that did not support the learning were avoided in order not to interfere with the process of understanding and jeopardise the learning process. Written text for key messages that corresponded in timing exactly with the audio content were presented on the screen simultaneously, so as to not split the learners attention. Photographic images were used to illustrate the audio content.

Table 17 describes the how the approaches to learning were applied to the design of the eLearning module.

Table 17. Study Two defining approaches to learning

Perspective	Associated Pedagogy	Instructional Design Principles
Associative	<ul style="list-style-type: none"> • Focus on competences • Clearly stated goals • Provision of feedback • Organised activity 	<ul style="list-style-type: none"> • Learners are tested pre-educational intervention in order to allow them to assess their own learning needs. They are then tested again post intervention to see whether they have achieved their learning outcomes • The module is broken down into instructional units and pre-determining choices exist within the course. • Demonstration videos are used to teach learners the required skills of hand expression and breast pump assembly.
Constructive	<ul style="list-style-type: none"> • Active construction and integration of concepts • Activities that encourage experimentation and discovery of principles • Support for reflection, peer review and evaluation 	<ul style="list-style-type: none"> • The information is presented in a systematic way to build the blocks of basic understanding before application of principles • Material is organized in small sections or 'chunks' (short films) to enable the learner to organise information without experiencing cognitive overload (1-4 minutes each) • Learning material (short films) can be watched repeatedly and at the users pace. • The learning module is limited to 30 minutes to prevent cognitive overload • Information is presented as audio visual as well as written in order to appeal to all learning styles • Evidence-based examples from research are cited • Accompanying log book has a section for reflection
Situative	<ul style="list-style-type: none"> • Participation in social practices of enquiry and learning • Support for development of learning skills 	<ul style="list-style-type: none"> • The learning material is presented in an evidence based context describing the personal experiences of mothers who express breast milk in NICU • Real time video of a mother being taught to express breast milk contextualises the learning in real practice • A sense of team building and responsibility may be fostered through the inclusion of local breastfeeding rates • Key information from the module and further resources are identified and listed in the log book

Development of content aligned to learning aims

Aim One: To improve knowledge of anatomy and physiology of breastfeeding

The animated film used to depict the hormonal pathways in the first study was evaluated well and was therefore used again in the second iteration. Image 5 shows the eLearning website housing the original video footage from study one. No changes were made to the content of this video. From the image it is also possible to see the content display down the left hand side of the page.

Image 5. Screenshot of webpage showing video describing the anatomy and physiology of milk production.

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Aim 2: To improve knowledge of the benefits of breastfeeding

Information for this aim was provided in a short video that used graphics and illustration to describe the benefits of breastfeeding.

Aim Three: To improve knowledge of breast milk expression

For the second iteration of the eLearning it was no longer possible to use the videos from Best Beginnings or the Health Talk website. Therefore, short animated films were developed to deliver a majority of the course content. In order to teach the specifics of both hand and pump breast milk expression it was deemed necessary to provide 'real' footage in order for the learner to be able to contextualise the information. Copyright was therefore sought and authorised to use a UNICEF video of a mother being taught to hand express. In order to provide information on breast pump expression a short film was made at Coventry University in which a volunteer member of staff from the NICU at UHCW agreed to teach the method for assembling a breast pump and describe the way it should be used on NICU (Image 6). This image also shows the breastfeeding Russian doll avatar.

Image 6. Screenshot of webpage showing the breast pump expression video

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Aim Three: To be able to provide breast milk expression support to mothers on NICU

In order to facilitate teaching mothers, a 'readiness to learn' framework of questions was included in the module. This guide helps the clinician to initiate a conversation about infant nutrition by enabling them to introduce the subject at an appropriate time whilst understanding the learning needs of the mother. This framework was originally used by (Hadsell 2010), who based it on educational research related to smoking cessation (Whyte et al. 2006), in which four key elements of health education were identified: the teachable moment, readiness to learn, information, and oral communication skills. Questions in the framework relate to experience, beliefs and the identification of barriers to learning.

The purpose of the guide is to perform a broad psychological assessment of the mother and it is underpinned by social constructivist theory. This suggests that an individual's perceptions, thoughts, emotions, interpretations, and responses to information and experiences are influenced by ethnicity, social class, gender, family life, past history, self-concept, and the learning situation itself. Hence asking key questions in order to frame the teaching in a way that matches these individualised needs is appropriate (Shapiro 2002). The mothers' response then guides the clinician in how motivated and psychologically stable they are, and gives an understanding of their readiness to learn.

In Table 18 each row represents a section of the psychological assessment, along with the general readiness category to which that section applies, the appropriate readiness question and the objective for asking that question. Questions may be asked in any order. Using the constructivist approach, the mother's previous experience can be associated with awareness of the need for learning whilst helping the clinician to modify the teaching plan to suit their specific needs. This avoids a situation where teaching is teacher-focused rather than learner-focused, as described in a critical ethnographic study of encounters between midwives and breastfeeding women in the postnatal period (Dykes 2005).

Table 18. Assessment for readiness to learn

A guide for assessing psychological readiness for learning about hand expression			
Psychological Assessment	Readiness Category	Readiness Question	Objective
Awareness	Prior knowledge and personal experience	Do you have any previous experience with breast milk expression	Draws on previous experience
Mood	Barriers to learning	Do you have any concerns about breast milk expression	Clarifies information
Affect	Knowledge, experience, barriers	Is this a good time for you to learn about breast milk expression?	Identifies current patient needs
Behaviour	Knowledge, experience, barriers	Is there anything that would prevent you from learning at this time?	Identifies barriers to learning
Thought Content	Knowledge, experience	What do you hope to learn during this teaching session?	Tailors teaching plan to mother

A second principle of social constructivism is that effective learning occurs through social interaction, collaboration, and negotiation, and this is brought about through face-to-face teaching between clinician and the mother. However it could be argued that although the teaching is being contextualised in this approach, the type of information given to the mother will follow a behaviourist model of learning. This is because hand expression is taught using a standardised approach, demonstrating how a specific action can bring about a specific effect and therefore result in a learnt behaviour. Learning theories can, therefore, be seen to blend in with one another to bring about a desired outcome. It is hard for any one theory to do justice to learning in all its diversity and many factors come into play that can affect both its meaning and value.

5.3.2 Stage 3 - Testing and refinement

Evaluation of Study Two

Aims

A second round of testing was conducted in order to evaluate the adequacy of the redesign measures and identify new challenges and successes. The methods of gathering and analysing the data were similar to the first study. A further 12 clinicians, who had not taken part in study one, undertook the eLearning module and NUCAT assessment and gave formal feedback. The aims of the evaluation were as follows:

1. To measure the eLearning module's impact on knowledge and confidence on a sample of neonatal clinicians using the NUCAT assessment tool.
2. To evaluate the NUCAT assessment questions through item analysis
3. To measure the eLearning module's usability through survey questions built into NUCAT

Aim 1

To measure the eLearning module's impact on the knowledge on a sample of n=12 neonatal unit clinicians using the NUCAT assessment tool

Descriptives

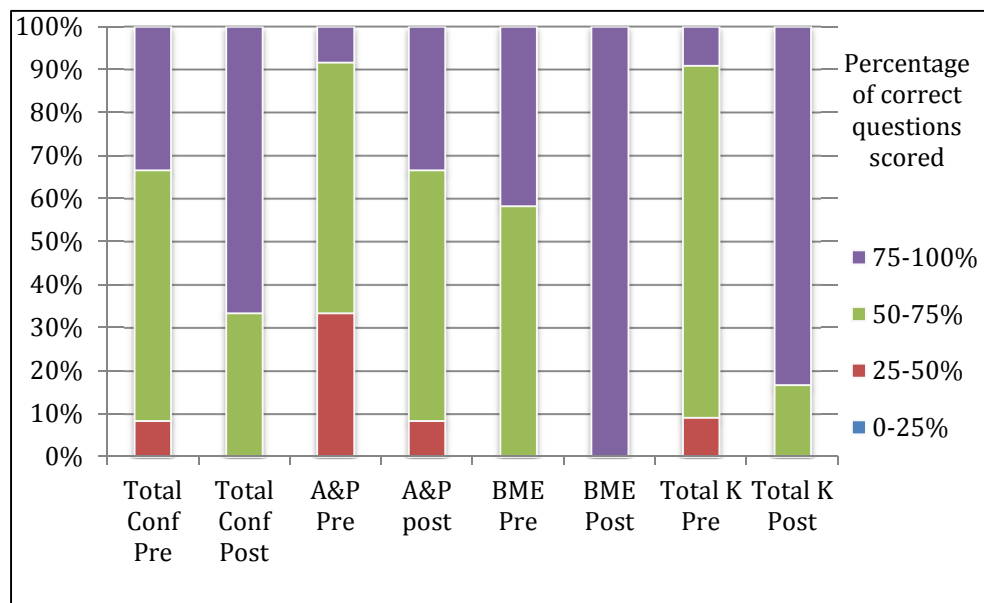
The second formal evaluation of the eLearning intervention was conducted in April 2014. In total, 12 clinicians (who had not participated in Study One) completed the eLearning module and NUCAT assessment. The participants included a student midwife, a nursery nurse and neonatal nurses (n=10), all of whom spent >75% of their working in clinical care. Half of the participants had received breastfeeding training within the last year (n=6), two had never received training and the remainder had not received training for over one year (n=4). Most had worked in NICU for over 5 years (n=7), two had worked there for less than 2 years and

the remainder had worked there between 2 and 5 years (n=3). They were aged between 20 and 39 years (n=8), or between 39-59 (n=4).

Results

Figure 13 shows the pre and post intervention test data as the proportion of clinicians who scored in each quartile pre and post intervention. This showed a significant improvement in knowledge and confidence scores post intervention. Further testing was undertaken using the paired-samples t-test to determine whether the mean difference between the paired observations was statistically significantly different from zero (Table 19). All of the grouped pairs showed statistically significant improvements in the mean score post intervention, suggesting that the intervention was effective in its aim of improving knowledge and confidence.

Figure 13. Study Two percentage of participants with correct scores for anatomy and physiology, breast milk expression and total knowledge



Legend

Pre = pre intervention

Post = post intervention

A and P = The anatomy and physiology of lactation score

BME = Breast Milk Expression score

Total K = Total Knowledge

Total Conf = Total Confidence

Table 19. Results from Study Two t-Tests

Pre and Post Test Subject	Pre- Intervention mean score (SD)	Post- Intervention mean score (SD)	<i>p</i> value
Total Confidence (1-60, ↑ = more confidence)	40.25 (9.62)	48.08 (5.38)	<i>p</i> < .01
Total Knowledge (1-20, ↑ = more knowledge)	13.17 (2.04)	17.42 (1.68)	<i>p</i> < .001
Knowledge in A and P (1-10, ↑ = more knowledge)	6.00 (1.95)	7.83 (1.48)	<i>p</i> = 0.01
Knowledge Breast Milk Expression (1-10, ↑ = more knowledge)	8.08 (1.17)	9.58 (0.52)	<i>p</i> < .001

Aim 2

To evaluate the NUCAT assessment questions through item analysis

NUCAT questionnaire analysis was undertaken as it was in study one of the pilot testing. The results shown in Table 20 show that baseline knowledge scores were fairly high for this cohort, except for two questions in the anatomy and physiology of lactation category (Q07 and Q12). This could be explained by the fact that the subjects were a highly motivated group of nurses who were prepared to take part in the pilot work for this research and they

therefore may have a special interest in breastfeeding. Despite the high baseline scores across a majority of the questions, the post intervention scores showed a statistically significant improvement. This was particularly notable for Q12 that showed only a very minor improvement in the first iteration, suggesting the changes that had been made for the second iteration had been successful.

Q25 showed no improvement in correct scores and it was therefore decided that it should be replaced with a more specific question that focused on the hand position of the mother as she hand expressed, as this is clearly described in the educational video used in study two. Q10 showed no improvement in correct scores, and all but one participant scored it correctly pre intervention. It was therefore decided that this question should be replaced with one that tested knowledge more thoroughly. Despite the hormone oxytocin being of key importance in the anatomy and physiology of breast milk production, no question item relating to it existed within the NUCAT question pool. A question item was therefore created in order to test this aspect of the eLearning intervention. This was developed with the help of a senior lecturer in Midwifery at Coventry University who had designed the original NUCAT assessment.

A table was created to match NUCAT questions to the eLearning content, in order to ensure that the eLearning module provided the necessary information to enable the learner to answer the question (Table 21). From this information it was possible to identify areas where the course content may need to be altered. This could then inform the next iteration of both the design of the eLearning module and the NUCAT assessment.

Table 20. Study Two pre and post intervention scores

Item Number	Question	Correct on Pre Test (total n=12)	Correct on Post Test (total n=12)
Q01	Which of the following hormones governs the production of milk components?	10	12
Q02	Which tissues within the breast are responsible for the secretion of milk components?	2	6
Q04	Which of the following can inhibit the milk ejection reflex?	11	12
Q05	What happens if milk is not removed from the breast?	12	12
Q06	According to autocrine theory, what is FIL (feedback inhibitor of lactation)	4	6
Q07	According to autocrine theory, where is FIL (feedback inhibitor of lactation) thought to exist?	2	6
Q08	What is the action of the Feedback Inhibitor of Lactation?	9	7
Q10	How does the composition of milk vary in the breast during a typical feed?	7	7
Q11	Which of the following breastmilk components promotes gut acidity, therefore preventing bacterial growth?	7	11
Q12	Human colostrum is particularly rich in which of the following vitamins?	2	11
Q16	Ideally, how soon after she has had her baby should a mother of a baby unable to breastfeed be encouraged to express milk?	12	12
Q19	How is milk removed during hand expression?	10	12
Q21	To maximize breast milk production, when should a mum move from hand expressing onto the pump?	11	12
Q22	When a mother is establishing lactation by expressing, how often should she express in a 24-hour period?	11	12
Q25	What is the best course of action if an expressing mother is not producing colostrum?	11	11
Q26	To maintain breastmilk production, which one of the following is the most important for mothers of premature and sick infants?	11	12
Q27	What volume of milk should a mother express a day by day 6 or 7, as an indicator of a good milk supply?	9	12
Q30	What is the longest time expressed breast milk can be safely stored in a refrigerator between 2-4°C ?	10	12
Q31	What is the recommendation regarding the storage of breast milk in a domestic freezer?	7	11
Q33	What is the safest method of defrosting expressed breast milk that has been frozen?	10	12

Table 21. Study two NUCAT question item with eLearning extract

<u>ITEM</u>	<u>QUESTION</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY TWO</u>	<u>SUBSTITUTE ITEM FOR STUDY 3</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT</u>
1.	Q01 Which of the following hormones governs the production of milk components?	A & P	Prolactin	'The level of prolactin in the blood remains high up to one and a half hours after the feed; thus sucking at one feed helps stimulate production of the milk for the next.' Coventry University Video				
2.	Q02 Which tissues within the breast are responsible for the secretion of milk components?	A & P	Acini	'When the prolactin in the blood comes into contact with the acini cells, milk is produced.' Coventry University Video				
3.	Q04 Which of the following can inhibit the milk ejection reflex?	A & P	Stress	'Milk ejection may be affected by pain, worry or stress and can cause the milk flow to slow or even temporarily stop flowing.' Coventry University Video				
4.	Q05 What happens if milk is not removed from the breast?	A & P	Milk production diminishes	'When the breast is not emptied, FIL remains in contact with the alveolar cells and this inhibits the secretion of milk constituents. This appears to be the mechanism of decreased milk production due to not emptying the breast.' Coventry University Video				
5.	Q06 According to autocrine theory what is FIL (feedback inhibitor of lactation)	A & P	A milk Protein	'A recently described milk protein FIL seems to play an important role in the continuation of milk supply.' Coventry University Video				

<u>ITEM</u>	<u>QUESTION</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY TWO</u>	<u>SUBSTITUTE ITEM FOR STUDY 3</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT</u>
6.	Q07 According to autocrine theory, where is FIL (feedback inhibitor of lactation) thought to exist?	A & P	Within the milk	'Fil acts locally within each breast and is secreted into breast milk.' Coventry University Video				
7.	Q08 What is the action of the Feedback Inhibitor of Lactation?	A & P	It inhibits the synthesis of milk constituents	'FIL inhibits the synthesis of milk constituents through a feedback mechanism.' Coventry University Video				
8.	Q10 How does the composition of milk vary in the breast during a typical feed?	A & P	High volume, low-calorie milk gradually changing to low volume, high-calorie milk	'The later milk is richer and higher in fat.' Coventry University Video	Q34 Which of the following statements is true of oxytocin?	Breast milk expression	It causes contraction of muscle cells in breast tissue	'Muscle cells, arranged in a basket-like weave, surround the sacs. The hormone oxytocin makes these muscles contract; ejecting the milk into the ducts of the alveoli and then into larger ducts.' Coventry University Video
9.	Q11 Which of the following breastmilk components promotes gut acidity, therefore preventing bacterial growth?	A & P	Bifidus Factor	'Human milk contains bifidus factor which encourages the growth of lactobacillus bifidus, this creates an acidic environment in the gut.' Coventry University Video				
10.	Q12 Human colostrum is particularly rich in which of the following vitamins?	A & P	Vitamins A and K	'Colostrum contains all the nutrients and protective factors of mature milk in higher concentrations and is very rich in proteins, vitamin A and K, and sodium chloride, but contains lower amounts of carbohydrates, lipids, and potassium.' Coventry University Video				

<u>ITEM</u>	<u>QUESTION</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY TWO</u>	<u>SUBSTITUTE ITEM FOR STUDY 3</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT</u>
11.	Q16 Ideally, how soon after she has had her baby should a mother of a baby unable to breastfeed be encouraged to express milk?	Breast milk expression	Within 6 hours	'Mothers should be encouraged to express within 6 hours of delivery as earlier initiation of breastfeeding following birth is associated with both longer duration of breastfeeding and increased milk volume.' Coventry University Video				
12.	Q19 How is milk removed during hand expression?	Breast milk expression	Compression of the ducts	'She compresses her breasts between thumb and forefinger... she adjusts her fingers so that milk is expressed from as many ducts as possible.' Hand Expression DVD				
13.	Q21 To maximize breast milk production, when should a mum move from hand expressing onto the pump?	Breast milk expression	When 10ml can be expressed at a time	'The mechanical means of expression may be preferable for most everyday use around day three, when the mother is producing around 10mls of milk each time she expresses.' Coventry University Video				
14.	Q22 When a mother is establishing lactation by expressing, how often should she express in a 24-hour period?	Breast milk expression	8-10 times	'Mothers should be encouraged to have a pumping routine and to express between 8 -10 times in a 24-hour period including once during the night.' Coventry University Vide				
15.	Q26 To maintain breastmilk production,	Breast milk expression	Continual and effective	'Continual and effective expression is the most				

<u>ITEM</u>	<u>QUESTION</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT STUDY TWO</u>	<u>SUBSTITUTE ITEM FOR STUDY 3</u>	<u>SCALE</u>	<u>ANSWER</u>	<u>E LEARNING CONTENT EXTRACT</u>
	which one of the following is the most important for mothers of premature and sick infants? colostrum?		expression of breastmilk	important factor in maintaining a good milk supply when a mum cannot breastfeed.' Coventry University Video				
16.	Q25 What is the best course of action if an expressing mother is not producing	Breast milk expression	Check her hand expressing technique	A mother may require support with hand expressing so it is important to check her technique is she is having difficulties.' Coventry University Video	Q 20 Where should the mother position her thumb and fingers when hand expressing?	Breast milk expression	2.5 - 4 cms back from the base of the nipple	'She adjusts her fingers so that they are 2.5 - 4 cms back from the base of the nipple' Hand expression DVD
17.	Q27 What volume of milk should a mother be expressing per day-by-day 6 or 7, as an indicator of a good milk supply?	Breast milk expression	500mls	'By day 6 or 7, this amounts to around 500mls/24 hours and should increase to over 800mls/24 hours by week 3-4.' Coventry University Video				
18.	Q30 What is the longest time expressed breast milk can be safely stored in a refrigerator between 2-4°C ?	Breast milk expression	Up to 48 hours	'Fresh EBM can be stored at room temperature for up to 4 hours or in a suitable fridge for up to 48 hours.' Coventry University Video				
19.	Q31 What is the recommendation regarding the storage of breast milk in a domestic freezer?	Breast milk expression	Breastmilk can be stored for up to 3 months	Frozen milk can be kept for up to 3 months. Coventry University Video				
20.	Q33 What is the safest method of defrosting expressed breast milk that has been frozen?	Breast milk expression	In a fridge	Frozen milk can be left to defrost slowly by leaving it in a refrigerator. Coventry University Video				

Table 22. Study two free text responses to individual NUCAT item questions

Question No	Question	Comment
Q21	To maximize breast milk production, how much milk should mum be hand expressing before moving onto the pump?	We have always been told once 20 mls is expressed
Q27	What volume of milk should a mother be expressing per day-by-day 6 or 7, as an indicator of a good milk supply?	Every woman is different some only produce small amounts others have 'gallons'!

Feedback on individual question items tabled above (Table 22) indicated the variety in clinician knowledge on this subject. This supports the need for clear education to guide practice and support the provision of consistent information and advice.

Aim 3

To measure the eLearning module's usability through survey questions built into NUCAT

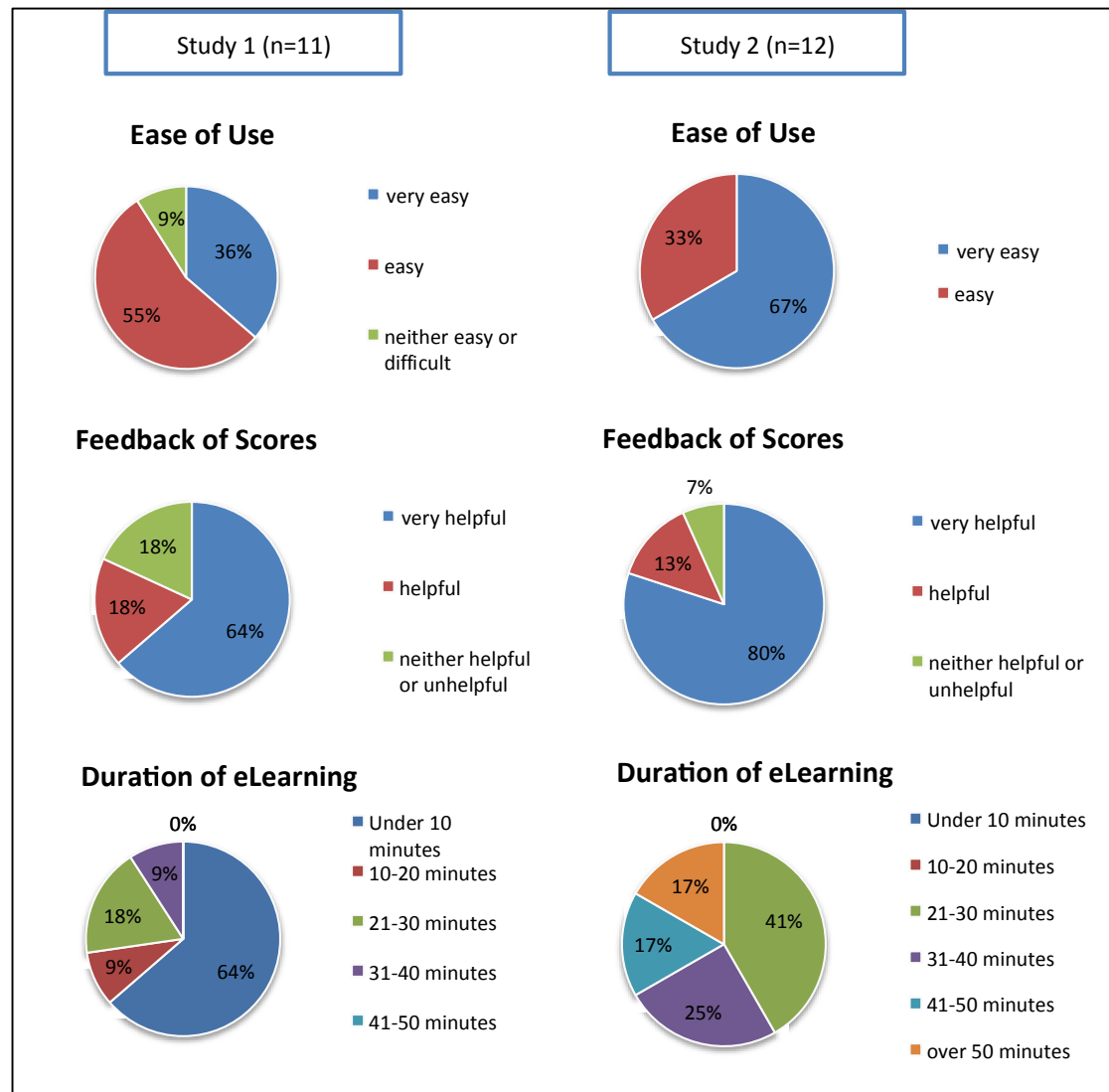
The following usability questions were asked of the participants following completion of the eLearning module and NUCAT assessment:

1. How would you rate the ease of use of the NUCAT e portal?
2. How long in minutes did it take you to complete the NUCAT eLearning module approximately (exclude any time taking breaks)?
3. How helpful was it to have the feedback of your percentage scores at the end of the NUCAT assessment?

Figure 14 compares the results from study one and two. These findings indicated an improvement in ease of use and helpfulness of scores, suggesting that the user had a more positive experience using this iteration. Importantly, more participants spent longer undertaking the training, demonstrating the success of using short animated videos to deliver

training content and suggesting that users may not spend enough time reading written information.

Figure 14. Pie charts to show comparisons in feedback from participants in Study 1 and Study 2



Free text boxes were provided at the end of the training session that asked the following questions:

1. Which aspects of the eLearning module did you find most useful?
2. In what ways do you think the eLearning module could be improved?

Further feedback was provided in the form of open text boxes (Table 23). These comments showed that clinicians felt that the training was suited to their learning needs and was provided in an accessible and enjoyable format.

Table 23. Study Two user feedback

<p>Most useful aspects:</p> <ul style="list-style-type: none"> • The section on troubleshooting common problems was very useful. • The videos on how to hand express and use the breast pump were particularly good, as this seems to be where most of our teaching to parents lies. • All • Hand expression and using the pump • Hand expressing • Pump demonstration was helpful. Physiology is always helpful, but it went very fast for me. • Hand expression and how to use the breast pump. • Anatomy and physiology • I felt the anatomy and physiology was very helpful as it is something I probably struggle with the most. Also ways to explain to mum why it is so important to express also helped • Information regarding Expressing milk, storage and using the pump • Video on how to use the breast pump. • Refreshing knowledge of A&P & the setting up the breast pump
<p>How could it be improved?</p> <ul style="list-style-type: none"> • It would be useful to have an option to complete the module silently/read it through (I first attempted it at work and it was distracting for those around me!). Excellent module, thank you. • I think it is a really good learning technique, and I have found it very beneficial. • Perhaps more questions. Maybe looking at problems mums have with their breasts. • I cant think of any

- I don't think it needs improving. It was very informative, easy to watch. Well explained.
- The physiology section went very fast.
- I would be interested to know which questions I specifically got wrong
- It would be helpful to know which questions I got wrong and the right answers
- I think it was very good
- To highlight the questions I actually got wrong and tell me the correct answers
- None-its very good.

5.3.3 Stage 4 - Practical redesign steps taken

The second iteration of the eLearning module was well evaluated, showing a significant improvement in the mean knowledge and confidence scores of participants. Importantly, there were no further technical issues with gaining access to the website or streaming videos and it was user-tested both in the hospital and the home environment, with one participant successfully using an iPad. A majority of the users completed the learning material in the desired time frame and the videos were very positively reviewed, which was reflected in the scores. One participant identified the issue of not knowing which answers she/he got wrong. This was an important learning point as knowledge could be furthered through the identification of incorrect questions. However, it was not possible to provide correct answers during the study, in order to control for confounders.

User testing during the study revealed a lack of sound quality on the videos. This was because the researcher made the original audio recordings at home using a pc. In order to further improve the final iteration of the module, the decision was made to re-record all the audio material in a professional studio at Coventry University. As a result of the evaluation, no further changes were necessary to the content of the module.

Whilst it could be argued that the numbers of participants in the first two evaluation studies may seem small, the main intention of usability testing is to quickly identify problems in order

to inform recurrent designs (Sanders 2010). Both these studies were successful in this aim and provided valuable information for developing the eLearning module used for the final study. The following chapter will describe the results from the main study that used the third iteration of the eLearning module.

5.4 Chapter Summary

This chapter presented the pilot work for the main study and provided a full description of the evaluation process that led to the design of the final eLearning intervention. Study One identified technical issues and indicated that users would prefer more video content in the training material. User scores in knowledge and confidence did not significantly improve following the intervention. Study Two did not identify any major concerns with the content of the eLearning module and user scores in knowledge and confidence did significantly improve. However, it was felt that the sound quality of the recordings used to narrate the videos lacked quality. NUCAT was evaluated in both studies and questions were identified that either did not assess knowledge effectively or were technically problematic. NUCAT question items were adjusted according to these findings. In order to improve the sound quality the entire audio content was rerecorded to a more professional level. The following Chapters (Six and Seven) present the findings from the final study that was undertaken in the same tertiary NICU at UHCW. Study Three aimed to recruit all members of the clinical team in order to fully evaluate the final version (Version 3) of the eLearning module and assess clinician knowledge and confidence both before and after undertaking the eLearning and measure retention of knowledge and confidence at 6-8 weeks using the NUCAT assessment tool.

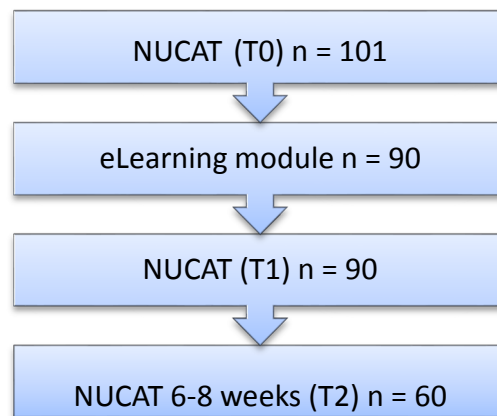
Chapter 6 – Evaluation Version Three of the eLearning Module: Knowledge and Confidence Outcomes

6.1 Introduction

Following the development of the eLearning module, reported in the previous chapter, this chapter reports the quantitative findings from the final study (Study 3) to evaluate the effects of the final iteration of the eLearning module (version 3) on clinicians' knowledge and confidence using the NUCAT assessment tool. The interventions and measurements were conducted at and between time points Time 0 (T0), Time 1 (T1) and Time 2 (T2) (Figure 14). At T0, the participants completed the demographics survey and the NUCAT assessment. Between T0 and T1, the participants undertook the eLearning module; on completion of the module (T1) participants completed the NUCAT assessment and evaluation of the eLearning module. At T2, 6-8 weeks after T1, retention of knowledge was measured by administering the NUCAT assessment (Figure 15).

Study Three was undertaken at UHCW NHS Trust between September and December 2014. In total, 125 health care professionals or health care professional students were approached at University Hospitals Coventry and Warwickshire NHS Trust and invited to take part in the study. For details of recruitment and consent see Chapter Four section 8. Participants who had taken part in any previous pilot studies were excluded from the final study. Those who agreed to take part (n=118) were then registered for the NUCAT assessment and eLearning module. Of these, 101 went on to complete the NUCAT pre intervention assessment, 90 participants completed the immediate post intervention assessment and a further 60 went on to repeat the assessment at 6-8 weeks.

Figure 15. Study Flow Design indicating participant numbers



6.2 Aims

1. To assess baseline (T0) knowledge of anatomy and physiology of lactation (A&P) and breast milk expression (BME) and how it differs by of job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training. ▪
2. To assess baseline (T0) confidence in knowledge and practice of A&P and BME and how it differs by job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training.
3. To assess post intervention (T1) knowledge of A&P and BME and how it differs by job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training. ▪
4. To assess post intervention (T1) confidence in knowledge and practice of A&P and BME, and how it differs by job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training.
5. To measure the mean change between pre and post intervention scores for total knowledge, knowledge in A &P, knowledge in BME, total confidence, confidence in knowledge and confidence in practice from T0 to T1 and whether sustained at follow up T2.

6.3 Analysis Aims 1 - 5

SPSS for Windows package version 22.0 was used for quantitative analysis. Characteristics of participants were calculated using descriptive statistics. Personal and job relevant information including job type, age, length of time working on NICU, percentage of working week spent in direct clinical care of babies and previous breastfeeding training were the independent variables. The mean total knowledge, knowledge in breast milk expression, knowledge in anatomy and physiology, total confidence, confidence in knowledge and confidence in practice scores were calculated as dependent variables.

The relationship between descriptive variables and mean total scores was examined to distinguish both the ability and learning needs of different participants pre intervention (T0), and to assess the impact of training on different participants post intervention (T1).

Descriptive statistics were used to present characteristics. The normally distributed results are reported with mean and standard deviation (SD). Analysis of variance (one way ANOVA) was conducted to determine if there was significant difference between the dependent and independent variables. The ANOVA provides an omnibus test of the differences across multiple groups and can therefore only identify general differences. In order to explore further any significant differences in the ANOVA results, post hoc testing using the Bonferroni adjustment method was used in order to reduce the risk of a type I error. A two-way mixed design ANOVA was conducted to explore the change of mean score in knowledge and confidence between pre and immediately post training intervention for different sub-groups. Further analysis to examine the mean change between pre and post training intervention scores for knowledge and confidence was undertaken with repeated-measures analysis of variance (ANOVA). This examined changes to mean scores pre-intervention (T0) to post intervention (T1) and post intervention (T1) to 6-8 weeks post intervention (T3). The statistical significance level was set at $p < 0.05$.

6.3.1 Characteristics of baseline study participants

The majority of participants in the study were female (90%). Job roles included nurses (n=52, 51%), doctors/Advanced Neonatal Nurse Practitioners (ANNPs) (n=25, 25%), nursery nurses (n=14, 14%) and students (n=10, 10%). In order to ensure groups were large enough to perform statistical tests, the demographic for length of time working on NICU was divided into those who had worked on the neonatal unit for > 5 years (n=56, 55%) and those who had worked < 5 years (n=45, 45%). All participants had undertaken some breastfeeding training and of those, 58 (57%) had received breastfeeding training within the last 6 months (Table 24)

Table 24. Baseline Characteristics of Study Participants

Demographic	Group	N (%)
Gender, n (%)	Male	10 (10)
	Female	91 (90)
Job Role, n (%)	Neonatal Nurse	52 (52)
	Nursery Nurse	14 (14)
	Dr/ANNP	25 (25)
	Student	10 (10)
Age range in years, n (%)	20-29	40 (40)
	30-39	27 (27)
	40 or over	34 (34)
How long worked on NICU, n (%)	< 5 years	56 (55)
	> 5 years	45 (45)
Time spent in clinical care of babies, n (%)	0-75%	33 (33)
	>75%	68 (67)
Recency of BF training, n (%)	0-6 months	58 (58)
	> 6 months	43 (43)

6.4 Results Aim 1

To assess **baseline knowledge** of anatomy and physiology of lactation and breast milk expression and how it differs by of job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training. •

Baseline knowledge

Results of the NUCAT assessment indicated that the mean score for total knowledge was 11.94 ($SD = 2.37$), with scores ranging from 8 to 17. Mean knowledge scores were higher across all groups in the subject breast milk expression $M = 7.33$ ($SD = 1.51$) than in the anatomy and physiology of lactation $M = 4.61$ ($SD = 1.74$). The subdivided areas of knowledge are further explored below.

Total knowledge

The one-way ANOVA (Table 24) results indicated that a significant difference existed in mean total knowledge in the job role group. Post hoc comparisons using the Bonferroni correction indicated that the mean score for total knowledge was statistically significantly higher ($p = 0.04$) in neonatal nurses ($M = 12.34$, $SD = 2.19$) than students ($M = 9.70$, $SD = 2.31$) and the mean score for total knowledge was statistically significantly higher ($p = 0.01$) in the doctor/ANNPs ($M = 12.36$, $SD = 1.91$, $p = 0.03$) than students ($M = 9.70$, $SD = 2.31$). In the age range group the ANOVA showed a statistically significant difference in mean scores for total knowledge. Bonferroni post hoc comparisons indicated a statistically significantly higher mean score ($p = 0.03$) in the over 40 years age group ($M = 12.79$, $SD = 2.40$) than those in the <30 years age group ($M = 11.40$, $SD = 2.40$) and a statistically significantly higher mean score ($p = 0.05$) in the over 40 years age group than those in the 30-39 years age group ($M = 11.37$, $SD = 1.82$). Total mean knowledge scores were statistically higher ($p = 0.02$) in participants who had worked on NICU for 5 years or more ($M = 12.48$, $SD = 2.41$) than those who had worked less than 5 years ($M = 11.38$, $SD = 2.39$). Likewise, participants who spent more than 75% of their working week in direct care of babies had statistically higher mean

scores ($p = 0.03$) in total knowledge ($M = 12.22$, $SD = 2.14$) than those who spent less than 75% of their working week in direct care of babies ($M = 11.12$, $SD = 2.60$). The only group that showed no statistically significant difference ($p = 0.39$) in mean total knowledge scores was the recency of breastfeeding training group.

Knowledge in breast milk expression

The one-way ANOVA (Table 23) results indicated that a difference in mean knowledge of breast milk expression in the job role group ($F(3,97) = 13.0$, $p < .001$). Bonferroni post hoc comparisons revealed that neonatal nurses had statistically significantly higher ($p < .01$) mean scores in knowledge of breast milk expression ($M = 8.02$, $SD = 1.47$) compared with all the other groups. Participants who had worked on NICU for 5 years or more had statistically higher ($p = 0.02$) mean scores in knowledge of breast milk expression ($M = 7.64$, $SD = 1.42$) than those who had worked for less time and spent less time in direct care of babies ($M = 6.89$, $SD = 1.60$). Participants who spent more than 75% of their working week in direct care of babies had statistically higher ($p = 0.02$) mean scores in knowledge of breast milk expression ($M = 7.47$, $SD = 1.43$), than those who spent less time in direct care of babies ($M = 6.73$, $SD = 1.70$). There were no statistically significant differences in mean scores in knowledge of breast milk expression by age ($p = 0.45$) or 'recency of breastfeeding training' ($p = 0.06$).

Knowledge in the anatomy and physiology of lactation

The one-way ANOVA (Table 25) results indicated that a difference in mean knowledge in the anatomy and physiology of lactation in the job role group ($F(3,97) = 11.23$ $p < .001$). Bonferroni post hoc comparisons revealed that doctors/ANNPs had statistically significantly higher ($p < .001$) mean scores in knowledge of anatomy and physiology of lactation ($M = 6.08$, $SD = 1.61$) compared with all the other groups. In the age range group the ANOVA showed a statistically significant difference in mean scores for knowledge in the anatomy and physiology of lactation ($F(2,98) = 4.05$ $p = 0.02$). Bonferroni post hoc comparisons indicated a statistically significantly higher ($p = 0.03$) mean score in those over 40 years of age ($M =$

5.29, $SD = 1.72$) than the <30 years age group ($M = 4.28$, $SD 1.70$). However, no statistically significant differences were found in mean scores in knowledge in the anatomy and physiology of lactation for length of time working on NICU ($p = 0.32$), percentage of working week spent in direct care of babies ($p = 0.33$) or the 'recency of breastfeeding training' group ($p = 0.06$)

Table 25. Baseline (T0) Knowledge Scores and Descriptive variables (n=101)

Descriptive	Range	N	Total Knowledge (scale range 0-20)			Breastmilk Expression Knowledge (scale range 0-10)			Anatomy and Physiology Knowledge (scale range 0-10)		
			mean	sd	anova	mean	sd	anova	mean	sd	anova
Job type	Neonatal Nurse	52	12.35	2.19		8.02	1.47		4.33	1.50	
	Nursery Nurse	14	10.71	2.50	F(3,97) =5.87 p<.01	6.71	1.90	F(3,97) =13.0 p<.001	4.00	1.18	F(3,97) =11.23 p<.001
	Dr/ANNP	25	12.36	1.91		6.28	1.73		6.08	1.61	
	Student	10	9.70	2.31		6.20	1.70		3.50	1.60	
Age range in years	<30	40	11.40	2.40		7.13	1.54		4.28	1.70	
	30-39	27	11.37	1.82	F(2,98) =4.38 p=0.02	7.04	1.40	F(2,98) =0.81 p=0.45	4.33	1.70	F(2,98) =4.05 p=0.02
	>40	34	12.79	2.40		7.50	1.70		5.29	1.72	
Length of time working on NICU	< 5 years	56	11.38	2.39	F(1,99) =5.72 p=0.02	6.89	1.60	F(1,99) =6.13, p=0.02	4.48	1.79	F(1,99) =0.98 p=0.32
	> 5 years	45	12.48	2.14		7.64	1.42		4.82	1.70	
Time spent in direct care of babies	0-75%	33	11.12	2.60	F(1,99) =5.14 p=0.03	6.73	1.70	F(1,99) =5.30, p=0.02	4.39	1.73	F(1,99) =0.96 p=0.33
	75% - >	68	12.22	2.14		7.47	1.43		4.75	1.71	
Recency of BF Training	0-6 months	58	12.03	2.40	F(1,99) =0.75 p=0.39	7.12	1.62	F(1,99) =0.64 p=0.24	4.91	1.68	F(1,99) =3.74 p=0.06
	> 6 months	43	11.65	2.30		7.53	1.36		4.13	1.63	

6.5 Results Aim 2

To assess **baseline confidence** in knowledge and practice of anatomy and physiology of lactation and breast milk expression, and how it differs by of job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training.

Baseline Confidence

Results of the NUCAT assessment indicated that the mean baseline score for total confidence in breastfeeding support was 35.58 ($SD = 10.39$) with scores ranging from 12 to 60. Mean confidence in knowledge scores were $M = 24.07$ ($SD = 6.47$) and mean scores for confidence in practice were $M = 11.75$ ($SD = 4.19$). The subdivided areas of confidence are further explored below.

Total Confidence

The one-way ANOVA (Table 25) results indicated that those who had worked on the NICU for 5 years or more scored statistically significantly higher mean scores for total confidence ($p = 0.04$). However, no statistically significant difference in total confidence mean scores was found between nurses, nursery nurses, doctors/ANNPs and students ($p = 0.18$), age groups ($p = 0.13$), percentage of working week spent in direct care of babies ($p = 0.40$) or in the 'recency of breastfeeding training' group ($p = 0.77$).

Total confidence in knowledge

The one-way ANOVA (Table 25) results indicated that those who had spent more than 5 years working on NICU scored statistically significantly higher ($p = 0.03$) mean confidence in knowledge ($M = 25.67$, $SD 9.71$) than those in the group who had worked 5 years or less ($M = 22.79$, $SD 6.53$). However, no statistically significant difference was found in mean scores for confidence in knowledge in the job role group ($p = 0.53$) 'age range' group ($p = 0.13$), the 'time spent in direct care of babies' group ($p = 0.67$) or 'recency of breastfeeding' training group ($p = 0.69$).

Total confidence in practice

The one-way ANOVA (Table 26) results indicated that a statistically significant difference in mean scores for confidence in practice, within these groups ($F(3,97) = 3.66, p = 0.02$). Post hoc comparisons using the Bonferroni correction indicated that the mean score for confidence in practice was statistically significantly higher ($p < .01$) for neonatal nurse ($M = 12.79, SD = 3.64$) than the doctor/ANNP group ($M = 9.56, SD = 4.86$). However, no statistically significant difference was found in mean scores for confidence in practice in the 'age range' group ($p = 0.36$), the length of time working on NICU group ($p = 0.10$), the 'time spent in direct care of babies' group ($p = 0.33$) or 'recency of breastfeeding' training group ($p = 0.91$).

Table 26. Baseline (T0) Confidence Scores and Descriptive variables (n=101)

Descriptive	Range	N	Total Confidence (scale range 1- 60)			Confidence in Knowledge (scale range 1-40)			Confidence in Practice (scale range 1- 20)		
			mean	sd	anova	mean	sd	anova	mean	sd	anova
Job type	Neonatal Nurse	52	37.71	9.65		24.92	6.19		12.79	3.64	
	Nursery Nurse /HCA	14	35.14	11.07	F(3,97) =1.67 p=0.18	23.64	6.80	F(3,97) =0.75 p=0.53	11.50	4.70	F(3,97) =3.66 p=0.02
	Dr/ANNP	25	32.16	12.09		22.60	7.51		9.56	4.86	
	Student	10	36.10	6.80		23.90	4.48		12.20	2.40	
Age range in years	<29	40	33.48	9.54		22.38	5.90		11.10	3.87	
	30-39	27	36.07	9.27	F(2,98) =2.11 p=0.13	24.30	5.65	F(2,98) =2.83 p=0.06	11.78	4.00	F(2,98) =1.03 p=0.36
	>40	34	38.82	11.76		25.88	7.32		12.50	4.70	
Length of time working on NICU	< 5 years	56	33.93	10.61	F(1,99) =4.31 p=0.04	22.79	6.53	F(1,99) =5.15 p=0.03	11.14	4.31	F(1,99) =2.70 p=0.10
	> 5 years	45	38.81	9.71		25.67	6.10		12.51	3.96	
Time spent in direct care of babies	0-75%	33	34.54	12.00	F(1,99) =0.70 p=0.40	23.67	7.50	F(1,99) =0.19 p=0.67	10.91	4.75	F(1,99)= 0.96 p=0.33
	75% - >	68	36.43	9.60		24.26	6.00		12.16	3.90	
Recency of BF Training	0-6 months	58	36.09	11.36	F(1,99) =0.87 p=0.77	24.30	6.90	F(1,99) =0.16 p=0.69	11.80	4.41	F(1,99) =0.01 p=0.91
	> 6 months	43	35.82	8.55		24.25	5.50		12.20	3.41	

6.6 Results Aim 3

To assess **change scores** in knowledge of anatomy and physiology of lactation and breast milk expression and how it differs by of job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training. •

In total 90 (89%) participants who undertook the baseline test went on to complete the training intervention and immediate post intervention NUCAT assessment.

Knowledge

A two way mixed design ANOVA was conducted to compare T0 and T1 mean total knowledge scores on the demographic subgroups for job role, age, length of time working on NICU, percentage of working week spent in direct clinical care of babies and recency of breastfeeding training. Repeated administrations of the NUCAT at two points in time: baseline (T0) and post intervention (T1) functioned as the repeated measures factor (Time) at two levels. The dependent variable was the NUCAT score. The parametric tests used were robust and analysis of the data indicated there was nothing to suggest any major violation of the underpinning parametric assumptions. Analysis revealed the main effect of the training intervention was significant within all demographic subgroups see Table 27 for within-subject effects. These results indicated that there was a significant increase in mean knowledge scores across all demographic groups following the eLearning intervention.

The interaction between **job role** and the training intervention was significant ($F(3,86) = 8.74, p = <.001$, partial $\eta^2 = .234$) indicating a large effect size and suggesting that job role had a differential effect on scores over time. Bonferroni post hoc analyses indicated that post-test mean total knowledge scores were greater in the Doctor/ANNP group compared to the nursery nurse group ($M = 2.87, SE = 0.71, p < .01$) and greater in the Doctor/ANNP group compared to the student group ($M = 2.26, SE = 0.734, p = 0.01$). Post-test mean total knowledge scores were also greater in the neonatal nurse group compared to the nursery

nurse group ($M = 2.04$, $SE = 0.65$, $p = .01$). Whilst all groups showed an improvement, the student and Doctor/ANNP group showed the most marked improvement in mean total knowledge scores following the intervention, suggesting that these groups found the training to be the most beneficial. Nursery nurses' mean scores increased the least.

There was no interaction between **age group** and the training intervention ($F(2,87) = 1.01$, $p = 0.37$, partial $\eta^2 = .023$) suggesting that pre and post intervention scores did not significantly differ by age group. However, there was a significant main effect for age group ($F(2,87) = 3.23$, $p = 0.04$, partial $\eta^2 = .069$) indicating a medium effect size and suggesting that participants mean total knowledge scores in different age groups varied significantly. Bonferroni post hoc analyses indicated that mean total knowledge scores were significantly greater in the over >40 years age group compared to <29 years age group ($M = 1.24$ $SE = 0.508$ $p = 0.04$) and this group had a higher baseline knowledge compared to both other groups.

The interaction between **time spent working on NICU** and the training intervention was significant ($F(1,88) = 5.82$, $p = 0.02$ partial $\eta^2 = .062$) indicating a small effect size and suggesting that the length of time spent working on NICU had a differential effect on mean total knowledge scores over time. Post hoc tests do not apply because this group only had two categories. Participants who had worked on NICU <5 years showed the greatest mean increase in post mean knowledge scores following the training module.

There was no interaction between **percentage of time spent in the direct care of babies** and the training intervention ($F(1,88) = 3.83$, $p = 0.07$ partial $\eta^2 = .037$) suggesting that total mean knowledge scores did not significantly differ in this demographic group over time.

There was no interaction between the **recency of breastfeeding training** group and the training intervention ($F(1,88) = 4.54, p = 0.21$ partial $\eta^2 = .018.$), suggesting that total mean knowledge scores did not significantly differ in this demographic group over time.

Table 27. Differences in mean total knowledge scores between pre and immediate post eLearning intervention in sub-groups

Items		N (90)	Time 0 (SD)	Time 1 (SD)	ANOVA Interaction effect	ANOVA Within-subject effect
Job Type	Neonatal Nurse	46	12.46 (2.22)	15.72 (2.26)	$F(3,86) = 8.74, p < .001$	$F(1,86) = 236, p < .001$
	Nursery Nurse	11	10.91 (2.55)	13.18 (2.90)		
	Dr/ANNP	23	12.39 (2.01)	17.43 (1.60)		
	Student	10	9.70 (2.31)	15.60 (2.50)		
Age range in years	<29	36	11.39 (2.46)	15.42 (2.31)	$F(2,87) = 1.01, p = 0.37$	$F(1,87) = 235, p < .001$
	30-39	23	11.48 (1.86)	15.78 (2.63)		
	>40	31	12.94 (2.34)	16.35 (2.60)		
Length of time working on NICU	< 5 years	49	11.39 (2.47)	15.82 (2.35)	$F(1,88) = 5.82, p = 0.02$	$F(1,88) = 244, p < .001$
	> 5 years	41	12.61 (2.08)	15.85 (2.70)		
Time spent in direct care of babies	<75%	30	11.30 (2.60)	15.83 (3.02)	$F(1,88) = 3.83, p = 0.07$	$F(1,88) = 238, p < .001$
	>75%	60	12.27 (2.19)	15.83 (2.23)		
Recency of BF Training	< 6 months	54	12.17 (2.36)	15.80 (2.54)	$F(1,88) = 4.54, p = 0.21$	$F(1,88) = 240, p < .001$
	> 6 months	36	11.61 (2.37)	15.89 (2.47)		

6.7 Results Aim 4

To assess **post intervention (T1)** confidence in knowledge and practice of anatomy and physiology of lactation and breast milk expression, and how it differs by of job type, age, length of time working on NICU, percentage of the working week spent in direct clinical care of babies and previous breastfeeding training.

Confidence

A two way mixed design ANOVA was conducted to compare T0 and T1 mean total confidence scores on the demographic subgroups for job role, age, length of time working on NICU, percentage of working week spent in direct clinical care of babies and recency of breastfeeding training. Repeated administrations of the NUCAT at two points in time: baseline (T0) and post intervention (T1) functioned as the repeated measures factor (Time) at two levels. The dependent variable was the NUCAT score. The parametric tests used were robust and analysis of the data indicated there was nothing to suggest any major violation of the underpinning parametric assumptions. Analysis revealed a significant main effect of the training intervention within all sub-groups (see Table 28 below for within-subject effects). These results indicated that there was a significant increase in mean confidence scores across all demographic groups following the eLearning intervention.

The interaction between **job role** and the training intervention was significant ($F(3,86) = 3.24, p = 0.03$, partial $\eta^2 = .101$) indicating a moderate effect size and suggesting that job role had a differential effect on mean total confidence scores over time.

There was no interaction between **age group** and the training intervention ($F(2,87) = 1.48, p = 0.24$, partial $\eta^2 = .033$) suggesting that total mean confidence scores did not significantly differ with age group over time. However, there was a significant main effect of age group ($F(1,87) = 3.23, p = 0.04$, partial $\eta^2 = .069$). Bonferroni post hoc analyses indicated that mean total confidence scores were greater in the >40 years age group compared to <29 years age

group ($M=4.71$ $SE = 1.86$ $p = .03$). The youngest age group (< 29 years) scored the lowest baseline mean confidence ($M = 33.58$ $SD = 9.73$) suggesting that they were the least confident in providing breastfeeding support.

The interaction between **length of time working on NICU** and the training intervention was significant ($F(1,88) = 11.15$, $p < .01$ partial $\eta^2 = .112$) indicating a moderate effect size. This suggests that total mean confidence scores differed in this demographic group over time. Post hoc tests do not apply because this group only had two categories. However, mean scores indicate that participants who had worked on NICU less than 5 years had a greater increase in total confidence following the training module baseline post intervention than those who had worked there for more than 5 years.

There was no interaction between **percentage of time spent in the direct care of babies** and the training intervention ($F(1,88) = 1.29$, $p = 0.26$ $\eta^2 = .014$) suggesting that total mean confidence scores did not significantly differ in this demographic group over time.

There was no interaction between **recency of breastfeeding training** and the training intervention ($F(1,88) = 0.27$, $p = 0.61$ $\eta^2 = .003$) suggesting that total mean confidence scores did not significantly differ in this demographic group over time.

Table 28. Differences in mean total confidence scores between pre and immediate post eLearning intervention in sub-groups

Items		N (90)	Time 0 (SD)	Time 1 (SD)	ANOVA Interaction effect	ANOVA Within-subject effect
Job Type	Neonatal Nurse	46	38.33 (9.79)	46.17 (7.17)		
	Nursery Nurse	11	36.55 (7.81)	44.09 (6.88)	$F(3,86) = 3.24, p = 0.03$	$F(1,86) = 103, p < .001$
	Dr/ANNP	23	32.39 (12.02)	46.04 (7.30)		
	Student	10	36.10 (6.80)	46.60 (7.31)		
Age range in years	<29	36	33.58 (9.73)	44.44 (6.37)	$F(2,87) = 1.48, p = 0.24$	$F(1,87) = 127, p < .001$
	30-39	23	35.87 (9.85)	46.09 (6.84)		
	>40	31	39.90 (9.90)	47.55 (7.90)		
Length of time working on NICU	< 5 years	49	34.12 (10.78)	46.14 (6.44)	$F(1,88) = 11.15, p < .01$	$F(1,88) = 137, p < .001$
	> 5 years	41	39.00 (8.60)	45.68 (7.88)		
Time spent in direct care of babies	<75%	30	35.13 (11.29)	46.07 (7.38)	$F(1,88) = 1.29, p = 0.26$	$F(1,88) = 124, p < .001$
	>75%	60	36.95 (9.48)	45.87 (7.02)		
Recency of BF Training	< 6 months	54	36.13 (11.25)	46.07 (7.89)	$F(1,88) = 0.27, p = 0.61$	$F(1,88) = 122, p < .001$
	> 6 months	36	36.67 (8.18)	45.72 (5.83)		

6.8 Results Aim 5

To measure the mean change between pre and post intervention scores for total knowledge, knowledge in A &P, knowledge in BME, total confidence, confidence in knowledge and confidence in practice from T0 to T1 and whether sustained at follow up T2.

In total 60 clinicians who went on to complete the NUCAT assessment at time 1,2 and 3. (Table 29)

Mean total knowledge scores over time

The results of the repeated measure ANOVA showed that mean total knowledge scores increased from T0 ($M = 12.12$, $SD = 2.48$) to T1 ($M = 15.95$, $SD = 2.60$) and then decreased at T2 (6-8 weeks) to ($M = 14.00$, $SD = 2.44$). Mauchly's test of sphericity indicated that the assumption of sphericity had not been violated, ($\chi^2(2) = 1.893$, $p = 0.39$). The training intervention elicited statistically significantly different mean total knowledge scores at the different time points, ($F(2, 118) = 79.679$, $p < .001$). Further post hoc test analysis was performed using Bonferroni in order to determine where the mean differences between the levels of the within-subjects factor lay. This demonstrated a statistically significant increase in mean total knowledge scores from T0 to T1 of 3.833, (95% CI [3.12, 4.54], $p < .001$) and a statistically significant increase in mean total knowledge scores from T0 to T2 of 1.833, (95% CI [1.16, 2.60] $p < .001$) (Table 29).

Mean anatomy and physiology of lactation knowledge scores over time

The results of the repeated measures ANOVA showed that mean anatomy and physiology knowledge scores increased from T0 ($M = 4.78$, $SD = 1.78$) to T1 ($M = 7.12$, $SD = 2.0$) and then decreased at T2 (6-8 weeks) to ($M = 5.67$, $SD = 1.73$). Mauchly's test of sphericity

indicated that the assumption of sphericity had not been violated, ($\chi^2(2) = 5.67, p = 0.06$). The training intervention elicited statistically significantly different mean anatomy and physiology knowledge scores at the different time points, ($F(2, 118) = 45.03, p < 0.001$). Further post hoc test analysis was performed using Bonferroni correction in order to determine where the mean differences between the levels of the within-subjects factor lay. This demonstrated a statistically significant increase in mean anatomy and physiology knowledge scores from T0 to T1 of 2.33, (95% CI [1.76, 2.90], $p < .001$) and a statistically significant increase in mean anatomy and physiology knowledge scores from T0 to T2 of 1.083, (95% CI [0.54, 1.63] $p < .001$).

Mean breast milk expression knowledge scores over time

The results of the repeated measure ANOVA showed that mean breast milk expression knowledge scores increased from T0 ($M = 7.33, SD = 1.63$) to T1 ($M = 8.83, SD = 1.20$) and then decreased at T2 (6-8 weeks) to ($M = 8.13, SD = 1.50$). Mauchly's test of sphericity indicated that the assumption of sphericity had not been violated, ($\chi^2(2) = 1.55, p = 0.46$). The training intervention elicited statistically significantly different mean breast milk expression knowledge scores at the different time points, ($F(2, 118) = 38.70, p < .001$). Further post hoc test analysis was performed using Bonferroni in order to determine where the mean differences between the levels of the within-subjects factor lay. This demonstrated a statistically significant increase in mean breast milk expression knowledge scores from T0 to T1 of 1.50, (95% CI [1.10, 1.91], $p < .001$) and a statistically significant increase in mean breast milk expression knowledge scores from T0 to T2 of 0.80, (95% CI [0.35, 1.25] $p < .001$).

Mean total confidence scores over time

The results of the repeated measure ANOVA showed that mean total confidence scores increased from T0 ($M = 36.98, SD = 10.04$) to T1 ($M = 45.73, SD = 6.97$) and then decreased at T2 (6-8 weeks) to ($M = 43.13, SD = 6.74$). Mauchly's test of sphericity indicated

that the assumption of sphericity had been violated, ($\chi^2(2) = 15.12, p = <.001$). Epsilon (ϵ) was 0.810, as calculated according to Greenhouse & Geisser, and was used to correct the one-way repeated measures ANOVA. The training intervention elicited statistically significantly mean total confidence scores at the different time points, ($F(1, 59) = 38.79, p < .001$). Further post hoc test analysis was performed using Bonferroni in order to determine where the mean differences between the levels of the within-subjects factor lay. This demonstrated a statistically significant increase in mean total confidence scores from T0 to T1 of 8.75, (95% CI [6.48, 11.08], $p < .001$) and a statistically significant increase in mean total confidence scores from T0 to T2 of 6.15, (95% CI [3.72, 8.58] $p < .001$).

Mean confidence in knowledge scores over time

The results of the repeated measure ANOVA showed that mean confidence in knowledge scores increased from T0 ($M = 24.85, SD = 6.31$) to T1 ($M = 30.57, SD = 4.56$) and then decreased at T2 (6-8 weeks) to ($M = 28.73, SD = 4.31$). Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, ($\chi^2(2) = 17.69, p = <.001$). Epsilon (ϵ) was 0.792, as calculated according to Greenhouse & Geisser, and was used to correct the one-way repeated measures ANOVA. The training intervention elicited significantly different mean confidence in knowledge scores at the different time points, ($F(2,93) = 51.75, p < .001$). Further post hoc test analysis was performed using Bonferroni in order to determine where the mean differences between the levels of the within-subjects factor lay. This demonstrated a statistically significant increase in mean confidence in knowledge scores from T0 to T1 of 5.72, (95% CI [6.48, 11.08], $p < .001$) and a statistically significant increase in mean confidence in knowledge scores from T0 to T2 of 3.88, (95% CI [2.24, 5.24] $p < .001$).

Mean confidence in practice scores over time

The results of the repeated measure ANOVA showed that mean confidence in practice scores increased from T0 ($M = 12.20, SD = 4.06$) to T1 ($M = 15.20, SD = 2.67$) and then decreased at T2 (6-8 weeks) to ($M = 14.43, SD = 2.73$). Mauchly's test of sphericity indicated that the

assumption of sphericity had been violated, ($\chi^2(2) = 9.01, p = .01$). Epsilon (ϵ) was 0.874, as calculated according to Greenhouse & Geisser, and was used to correct the one-way repeated measures ANOVA. The training intervention elicited statistically significant mean confidence in practice scores at the different time points, ($F(2, 103) = 42.17, p < .001$). Further post hoc test analysis was performed using Bonferroni in order to determine where the mean differences between the levels of the within-subjects factor lay. This demonstrated a statistically significant increase in mean confidence in practice scores from T0 to T1 of 3.00, (95% CI [2.06, 3.94], $p < .001$) and a statistically significant increase in mean confidence in practice scores from T0 to T2 of 2.23, (95% CI [1.35, 3.12] $p < .01$).

Table 29. Changes in Scores Over Time

	Time 0			Time 1		Time 2	
	N	Mean	SD	Mean	SD	Mean	SD
Total Knowledge (max. score 20)	60	12.12	2.48	15.95	2.60	14.00	2.44
Anatomy and Physiology knowledge (scale 0-10)	60	4.78	1.78	7.12	2.00	5.87	1.73
Breast milk Expression knowledge (scale 0-10)	60	7.33	1.63	8.83	1.21	8.13	1.50
Total Confidence (scale 0-60)	60	36.98	10.04	45.73	6.97	43.13	6.74
Confidence in Knowledge (scale 0-40)	60	24.85	6.39	30.57	4.56	28.73	4.31
Confidence in Practice (scale 0-20)	60	12.20	4.06	15.20	2.67	14.43	2.73

6.9 Discussion

Findings relating to clinicians' baseline total knowledge and total confidence

Knowledge

Participants had higher mean baseline knowledge scores in the subject area of breast milk expression than the anatomy and physiology of lactation. These findings reflect those of an earlier study that used NUCAT to assess the knowledge of NICU clinicians at UHCW and found that the anatomy physiology section to be the lowest scoring subject area (Wallace et al. 2013). Studies that have evaluated breastfeeding knowledge outside of the NICU context have also reported gaps in baseline knowledge in the anatomy and physiology of lactation (Ahmed and Guindy 2011; Deloian et al. 2015). This would suggest that this subject area requires educational focus and its inclusion in this training module was justified.

Whilst all participants had received breastfeeding training baseline total knowledge was not affected by the recency of training. This suggests that current training provision may not provide information that is being tested in NUCAT, though those who had been trained more recently did have a higher mean score. Doctors and ANNPs, those in the 'over 40' age group, those who had worked on NICU for more than 5 years and spent more than 75% of their working week in direct clinical care of babies had higher mean total knowledge scores, supporting Bernaix et al.'s (2009) findings that reported higher knowledge scores with greater experience. These results suggest that clinical experience and training at medical or advanced nurse level provide clinicians with better baseline total knowledge. However, this is in contrast to the findings of Siddell et al. (2003) who report that those who had worked on NICU the longest were those that would most benefit from the educational intervention. The other studies from the literature review (Chapter 2 section 3) did not report knowledge results in relation to participant characteristics. However, Bernaix et al. (2008) report that age and experience correlated with intention to provide lactation support.

All participants had received some form of breastfeeding education but this did not statistically affect scores. However, those who had been trained more recently did have higher baseline knowledge scores. Siddell (2003) performed regression analysis and found the only significant predictor of knowledge scores to be higher education attained in nursing. This thesis did not examine the education level of staff but it would have been expected that those who had received training within six months of undertaking the NUCAT assessment should have performed significantly better in knowledge attainment.

Baseline knowledge scores in breast milk expression were significantly higher in neonatal nurses, those who had worked on NICU for more than 5 years and those that spent more than 75% of their working week in direct clinical care of babies. This finding suggests that clinical experience informs knowledge in this area. Baseline knowledge scores in the anatomy and physiology of lactation were significantly higher for doctors and ANNPs and those in the 'over 40' age group scored. This result is perhaps to be expected as the doctor/ANNP group may have spent more time in their training learning anatomy and physiology whereas nurses and nursery nurses may have spent more time studying the practical aspects of breastfeeding support.

Confidence

When confidence ratings were subdivided into confidence in knowledge and confidence in practice, only those who had worked on NICU for more than 5 years were more confident in their knowledge of breastfeeding support than those who had worked for less than 5 years. Those with more clinical experience did have higher baseline total knowledge and knowledge in breastmilk expression, therefore their confidence was well placed. Neonatal nurses were the only sub group who scored significantly higher means for confidence in practice. As expected, nurses rated themselves as more confident in the practical aspects of supporting a mother to breastfeed than the medical team and their knowledge scores were significantly higher in breast milk expression than the other groups, which suggest that this confidence is well placed. However, they were not more confident in their knowledge than any other of the

groups. Time spent in direct care of babies and previous breastfeeding training did not impact on participants' confidence in knowledge or practice, though those groups who had not received training within 6 months and spent less time in clinical care of babies did have lower mean scores.

Findings relating to clinicians' post intervention total knowledge and total confidence

Results indicated that scores increased significantly following the training across all subgroups in both total knowledge and total confidence and this did not significantly decrease at 6-8 weeks. The doctor/ANNP group showed the biggest improvement in knowledge scores and nursery nurses the least. This may suggest that nursery nurses do not find eLearning a suitable form of training or that they require further education and support. Mean scores indicated that confidence significantly increased post intervention in the doctor/ANNP group and in those who had worked on NICU for less than 5 years more suggesting that those who have had less exposure to clinically supporting mothers with breastfeeding found the eLearning module particularly helpful in improving their confidence. Baseline total confidence scores were lowest in the nursery nurse group and although this did improve this was not statistically significant. This is, however, an important finding because it suggests that those who provide the most breastfeeding support are those with the least self reported confidence.

This study is consistent with those in the literature review (Chapter Two, section three) that found an improvement in knowledge following a training intervention. However, our study was larger than any of the studies in this review, gathering baseline data on 101 clinicians and immediate post-test data on 90. Bernaix et al (2008) were the only study that looked at knowledge retention at 3 months post intervention found no improvement over pre-test scores, whereas our study did show an improvement scores over baseline results at 6-8

weeks. Our study did show a decline in knowledge retention and this may indicate that clinicians require regular updates, perhaps at 3-6 month intervals, in order to be able to recall information accurately.

Despite the doctor/ANNP group having higher knowledge scores than other groups both at baseline and following the intervention their confidence to provide breastfeeding support pre intervention was the lowest amongst all the groups. This could be as a result of the content of the eLearning module focusing on practical aspects of support. However this group's confidence scores increased significantly over all the other groups following the intervention. This group's success with using the eLearning suggests that it is a method of teaching they are comfortable with. Other breastfeeding educational interventions aimed at doctors have reported improvement in knowledge post intervention but studies have not measured confidence as an outcome (Velillas et al. 2007; Lewin and O'Connor 2012; Holmes et al. 2012).

Our study reported increased confidence following the eLearning intervention. Although confidence was not measured as an outcome in any of the studies in the literature review it is a recognised outcome of other breastfeeding educational intervention studies that have taken place outside of the NICU context (Lahti et al. 2014; Kronborg et al. 2008; Khoury et al. 2002). Confidence is important because when perceived self-efficacy is high, learners are more likely persist with tasks that may be academically challenging and they are also more likely to monitor the quality of their work through frequent reflection (Pajares 2002). Feedback of scores can further strengthen clinicians' self-efficacy as it provides them with the knowledge that they have successfully completed a task (Bandura 1986).

Although nursing attitudes and behaviour towards breastfeeding support were not explored in this study there is evidence that nurses response to learning may vary by personal factors, including age, education, knowledge, and experience. Siddell et al. (2003) and Bernaix et al. (2010) studied the influence of personal characteristics and other factors on maternity nurses'

ability to provide effective breastfeeding support to mothers and found that knowledge and intentions were associated with nurses' ability to promote breastfeeding. Bernaix et al. (2010) concluded that since knowledge is predictive of supportive behaviour, nurses' knowledge must be accurate and complete to effectively assist breastfeeding mothers. This finding was further supported by Kronborg et al. (2008) who found that the health visitors' knowledge, but not their positive intention, was associated with their actual supportive behaviour as perceived by the mothers. These findings indicate that clinically relevant knowledge is important in influencing supportive breastfeeding behaviour among health professionals and supports the need for accurate assessment of educational interventions such as used in this study in order to verify levels of clinician knowledge in this subject.

6.11 Chapter summary

This chapter reported the quantitative findings from Study Three that evaluated Version 3 of the eLearning module. The intervention was successful in improving the knowledge and confidence of neonatal clinicians to support breastfeeding practices and maintaining improvement at 6-8 weeks. The following chapter reports the findings from the evaluation of the eLearning module and NUCAT assessment along with results from clinician interviews.

Chapter 7 - Evaluation of Version Three of the eLearning Module: Analysis of User Feedback

7.1 Introduction

This chapter presents the qualitative findings from Study Three. This was an explorative study to evaluate the final iteration of the eLearning module (Version 3) that used item analysis, participant question feedback, survey questions and clinician interviews to gather data. All participants who undertook the NUCAT assessment were invited to comment on both the individual question items and their experience of undertaking both the assessment and the eLearning module.

7.2 Aims

1. To evaluate the NUCAT assessment questions through item analysis
2. To measure the eLearning module's usability through survey questions built into NUCAT
3. To explore clinicians' experience of using the eLearning module and NUCAT assessment tool through semi-structured interviews.

7.3 Results Aim 1

To evaluate the NUCAT assessment and eLearning module using question analysis and user feedback.

7.3.1 NUCAT item analysis

Table 30 presents the questions and percentage of participants who scored correctly pre and post intervention. Paired sample t-tests identified the questions that showed a statistically significant increase in correct answers post intervention. In total 13 questions out of 20

showed a statistically significant improvement in correct answers following the training intervention. Participant baseline knowledge was better in the subject area of breast milk expression (mean score 42%) than the anatomy and physiology of lactation (mean score 69%). However, the improvement in scores was statistically significant in both subject areas. Q12, (asking which vitamins were present in colostrum), scored the least correct answers on pre intervention assessment. Baseline knowledge concerning what happened if milk was not removed from the breast (Q05) and on how often mothers should express breast milk (Q26) showed the highest baseline correct answers.

Participant baseline knowledge was better in the subject area of breast milk expression than the anatomy and physiology of lactation. Prior to undertaking the eLearning participants knew that breast milk supply would cease if milk was not removed from the breast and that a mother should be encouraged to express within 6 hours of delivering her baby. They were also aware of how long milk should be stored in the refrigerator; therefore these questions may not be a good test the effectiveness of the training intervention. The question that participants found the most difficult related to the vitamins present in colostrum, only 15% of participants answered this correctly (where there is a chance score of 25%). However, following the intervention 86% of participants answered this question correctly. Less than 25% of participants knew the correct answer to three questions relating to the feedback inhibitor of lactation. Following the training this number increased significantly, however this still resulted in around only half of the participants answering these question correctly which suggests that these questions may be too difficult or the eLearning if not effective in providing knowledge. Questions that showed no improvement in questions answered correctly generally had a very high baseline percentage of correct scores (77% or above). The only question that did not show a significant improvement with a low baseline was one relating to the feedback inhibitor of lactation, with a baseline number of correct answers of 46% increasing to only 52% post intervention. This suggests that either the training module did not deliver the information in an effective way or the question is too difficult. Questions

relating to the feedback inhibitor of lactation should be re-evaluated if they are to remain part of the assessment or future versions of the training should address this issue.

Table 30. Study Three pre and post intervention scores

Item Number	Question Item	Correct Pre Intervention (n=90)	Correct Post intervention (n=90)	Paired Sample t Test (p value)
Q01	Which of the following hormones governs the production of milk components?	70 (77%)	69 (76%)	1.00
Q02	Which tissues within the breast are responsible for the secretion of milk components?	17 (18%)	46 (50%)	< .001
Q04	Which of the following can inhibit the milk ejection reflex?	66 (72%)	86 (95%)	< .001
Q05	What happens if milk is not removed from the breast?	87 (95%)	88 (93%)	.74
Q06	According to autocrine theory, what is FIL (feedback inhibitor of lactation)?	21 (23%)	50 (55%)	< .001
Q07	According to autocrine theory, where is FIL (feedback inhibitor of lactation) thought to exist?	23 (25%)	40 (43%)	.004
Q08	What is the action of the Feedback Inhibitor of Lactation?	42 (46%)	47 (52%)	.356
Q11	Which of the following breast milk components promotes gut acidity, therefore preventing bacterial growth?	59 (65%)	87 (95%)	< .001
Q12	Human colostrum is particularly rich in which of the following vitamins?	14 (15%)	78 (86%)	< .001
Q34	Which of the following statements is true of oxytocin?	24 (26%)	45 (51%)	< .001
Q16	Ideally, how soon after she has had her baby should a mother of a baby unable to breastfeed be encouraged to express milk?	87 (95%)	90 (99%)	.320
Q19	How is milk removed during hand expression?	80 (88%)	81 (87%)	.640
Q20	Where should the mother position her thumb and fingers when hand expressing?	36 (39%)	75 (82%)	< .001
Q21	To maximize breast milk production, when should a mum move from hand expressing onto the pump?	53 (58%)	73 (80%)	< .001
Q22	When a mother is establishing lactation by expressing, how often should she express in a 24-hour period?	70 (77%)	84 (92%)	< .001
Q26	To maintain breast milk production, which one of the following is the most important for mothers of premature and sick infants?	77 (85%)	82 (90%)	.198
Q27	What volume of milk should a mother be expressing per day, by day 6 or 7, as an indicator of a good milk supply?	60 (66%)	76 (84%)	< .001

Q30	What is the longest time expressed breast milk can be safely stored in a refrigerator between 2-4°C?	64 (70%)	86 (95%)	< .001
Q31	What is the recommendation regarding the storage of breast milk in a domestic freezer	87 (95%)	86 (95%)	1.00
Q33	What is the safest method of defrosting expressed breast milk that has been frozen?	78 (86%)	88 (97%)	<.01

7.3.2 NUCAT question feedback

Participants were invited to comment on NUCAT question items in order to provide user feedback and verify NUCAT face validity. Table 31 below lists the individual questions, their correct answer and the participants comment. In total 15 out of the 20 questions provoked responses. A number of these responses queried the accuracy of the information given in NUCAT. Participants questioned some of the terminology that NUCAT used but these responses were mostly inaccurate, such as describing bifidus factor as lactobacillus (Q11). One of the questions that created the greatest interest was the one asking which vitamins were present in colostrum (Q12). NICU clinicians are aware that low levels of vitamin K can result in haemorrhagic disease of the newborn and because of this all babies are given supplementary vitamin K immediately after birth. Participants felt that this question was misleading, however one participant believed that breast fed babies are more at risk of haemorrhagic disease of the newborn which is inaccurate. Future versions of NUCAT should carefully consider including this question if it results in confusing clinicians on the imperative need for a baby to receive vitamin K supplements immediately following delivery (Hey, 2003). Questions relating to the recommended storage times for breast milk (Q30, Q31) also generated a number of participant responses. This was because advice concerning breast milk storage can differ across independent units and also differs from that for well, term babies. Consequently clinicians who had worked in other areas believed that the answers provided in NUCAT were inaccurate.

When asked what volume of milk a mother should produce by day 6 or 7 (Q27), one participant commented that this would vary between mothers. Whilst this response is of course true, it potentially reflects the attitude of staff who do not engage in the necessity to provide this type of advice to mothers, or who are not able to recognise when a mother is struggling to produce breast milk. Some participants felt that the answer relating to initiating breast milk expression (Q16) was too conservative (within 6 hours of delivery) and the correct answer would be for mothers to express as soon as possible and preferably earlier than within 6 hours of delivery. Another participant recognised that this was not always possible if the mother had experienced a very difficult delivery.

Table 31. Study Three free text responses to individual NUCAT item questions

Item Number	Question	Answer	Participant comment
Q02	Which tissues within the breast are responsible for the secretion of milk components?	Acini	<ul style="list-style-type: none"> I'd call it the alveolus
Q04	Which of the following can inhibit the milk ejection reflex?	Stress	<ul style="list-style-type: none"> I have put stress as an answer, I also think poor fluid intake. Working on the neonatal unit we have mums who want to spend time with baby can result in poor diet and fluid intake because they want to spend time with baby. I think the two go hand in hand
Q05	What happens if milk is not removed from the breast?	Milk production diminishes	<ul style="list-style-type: none"> The breast can become engorged making it painful for mum to feed I think it causes pain as well
Q06	According to autocrine theory, what is FIL (feedback inhibitor of lactation)?	A milk protein	<ul style="list-style-type: none"> I'd call it a hormone not a receptor
Q07	According to autocrine theory, where is FIL (feedback inhibitor of lactation) thought to exist?	Within the milk	<ul style="list-style-type: none"> Again I'd call it the alveolar cells
Q11	Which of the following breast milk components promotes gut acidity, therefore preventing bacterial growth?	Bifidus factor	<ul style="list-style-type: none"> Lacto bacillus
Q12	Human colostrum is particularly rich in which of the following vitamins?	A & K	<ul style="list-style-type: none"> I think that A B & E are the most prevalent Babies are given vitamin K after birth Had to guess that one I don't agree with Ticking K. Vitamin K deficiency bleeding of the new born is more common in breast fed babies for the very reason that breast

			<p>milk has very LOW Vit K levels</p> <ul style="list-style-type: none"> Colostrum is rich in vitamin A, B12 and D Vit K is not rich in breast milk we have to prescribe two doses of Vit K for babies who are breastfed v babies who are formula fed as formula contains sufficient Vit K.
Q16	Ideally, how soon after she has had her baby should a mother of a baby unable to breastfeed be encouraged to express milk?	Within 6 hours	<ul style="list-style-type: none"> Should be ASAP When this is possible things to consider if mum has had a difficult delivery this may not be possible Should be earlier than 6 hrs. But no option
Q21	To maximize breast milk production, when should a mum move from hand expressing onto the pump?	When 10 ml can be expressed at a time	<ul style="list-style-type: none"> Medela rep recommend at 20mls 3 to 4 days
Q22	When a mother is establishing lactation by expressing, how often should she express in a 24-hour period?	8-10 times	<ul style="list-style-type: none"> Now recommended UNICEF 8 - 12 times in 24 hours ABM recommend 8-12 times so this could be one of 2 answers
Q26	To maintain breast milk production, which one of the following is the most important for mothers of premature and sick infants?	Continual and effective expression of breast milk	<ul style="list-style-type: none"> I think two answers adequate rest is important I was torn between maternal health depending on mum post delivery Effective breast milk expression, using breast massage to aid this, and adequate rest - are the options I would say are important
Q27	What volume of milk should a mother be expressing per day-by-day 6 or 7, as an indicator of a good milk supply?	500mls	<ul style="list-style-type: none"> I feel that this is an individual thing as each mum is different and expresses different volume at different times.
Q30	What is the longest time expressed breast milk can be safely stored in a refrigerator between 2-4 degrees Celsius?	Up to 48 hours	<ul style="list-style-type: none"> Good question as health care professionals need to give consistent advice to parents about storage of milk because parents will often bring milk in from home. Actually UNICEF and DH suggest 5 days. Can be stored up to 5 days at or below 4 C. <p>Reference: http://www.nhs.uk/Conditions/pregnancy-and-baby/pages/expressing-storing-breast-milk.aspx#close</p> <ul style="list-style-type: none"> Up to 8 days!!!
Q31	What is the recommendation regarding the storage of breast milk in a domestic freezer?	3 months	<ul style="list-style-type: none"> 6 months in deepfreeze Depending on how often freezer opened also the star setting does this affect it Milk can stay in freezer up to 6 months as per NHS choice website - http://www.nhs.uk/conditions/pregnancy-and-baby/pages/expressing-storing-breast-milk.aspx#close 6 months in deepfreeze Depending on how often freezer opened also the star setting does this affect it Milk can stay in freezer up to 6 months as per NHS choice website - http://www.nhs.uk/conditions/pregnancy-and-baby/pages/expressing-storing-breast-milk.aspx#close

			baby/pages/expressing-storing-breast-milk.aspx#close
Q33	What is the safest method of defrosting expressed breast milk that has been frozen?	In the fridge	<ul style="list-style-type: none"> • In the fridge it wouldn't let me submit it • Breast milk should be labelled with the time it was taken out the freezer and date. Put to defrost in a clean and safe place for defrosting.

7.3 Results Aim 2

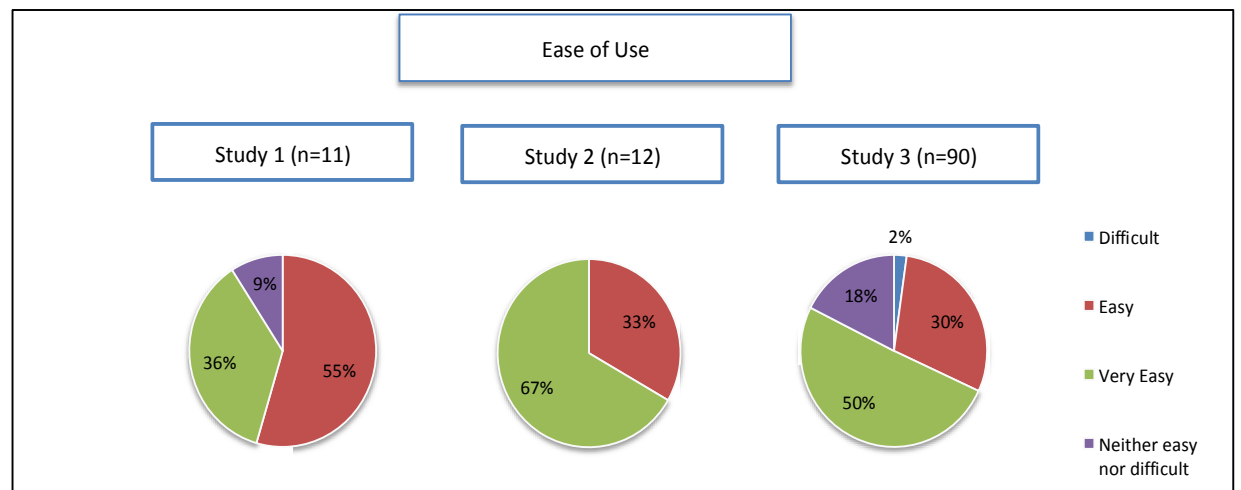
To measure the eLearning module's usability through survey questions built into NUCAT

In order to gain user feedback in this study the following questions were asked:

1. How would you rate the ease of use of the NUCAT e portal?
2. How long in minutes did it take you to complete the NUCAT eLearning module approximately (exclude any time taking breaks)?
3. How helpful was it to have the feedback of your percentage scores at the end of the NUCAT assessment?

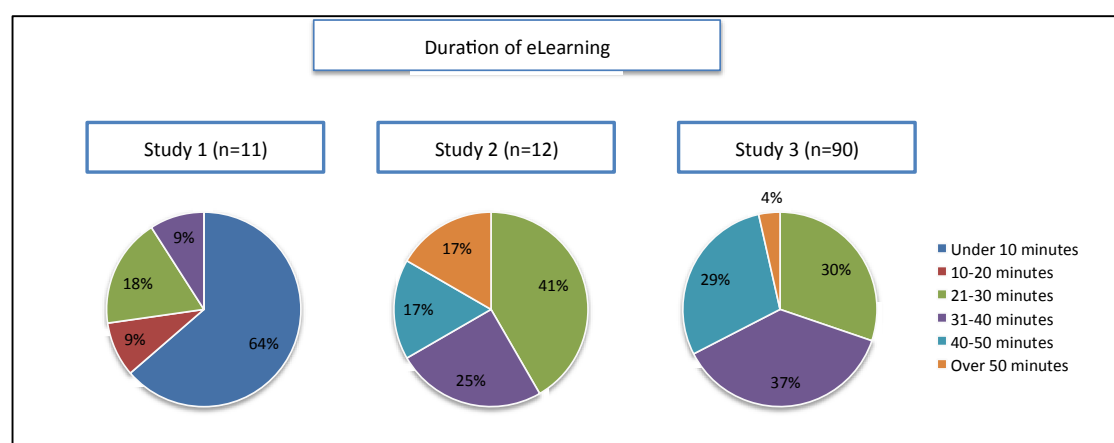
The pie charts in Figure 16 compare results from both the user-testing studies and the final study. A majority of participants in the final study (Study 3) found it user friendly; 27 participants found the eLearning module easy to use, 46 participants found it very easy to use whilst only two participants found it difficult. This was consistent across the earlier studies in which a majority of users found the eLearning easy or very easy to use.

Figure 16. Study Three pie charts to show comparisons in feedback for ease of use from participants in Study 1, 2 and 3



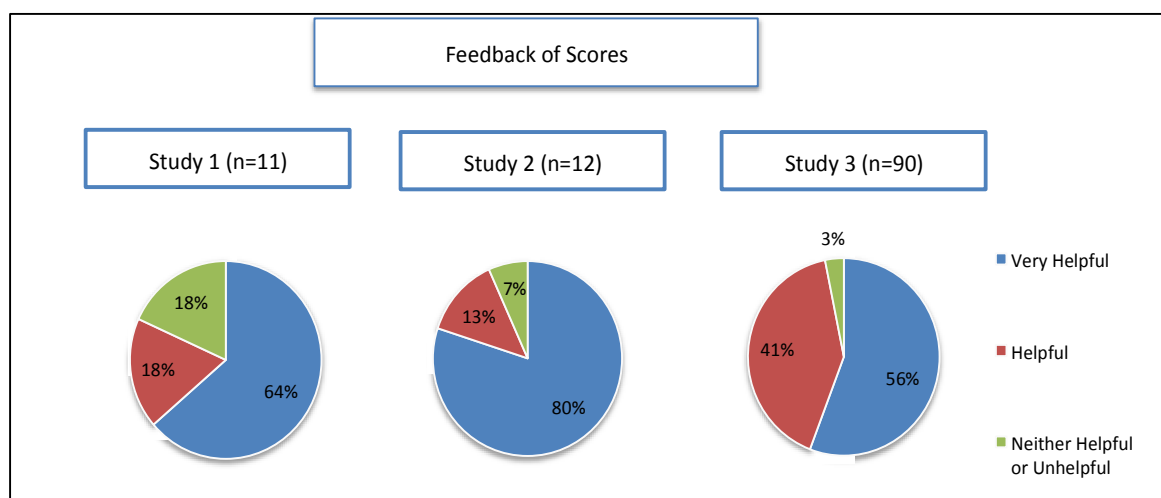
The pie charts in figure 17 compare results from both the user-testing studies and the final study to illustrate the length of time participants spent undertaking the eLearning. The majority of participants (n=57) in Study 3 took between 30 and 50 minutes to complete the eLearning module. The figure below shows that there was a dramatic increase in the time it took to complete the eLearning from study 1 to study 2, and this increase in time was sustained in Study 3.

Figure 17. Study Three pie charts to show comparisons in feedback duration of learning from participants in Study 1, 2 and 3



The pie charts in figure 18 compare results from both the user-testing studies and the final study to illustrate how useful participants found the feedback of scores following the assessment. In the final study the majority of the participants found the use of feedback scores very helpful or helpful. A large majority of participants in the final study found the feedback very helpful, and this remained consistent across all the studies.

Figure 18. Study Three pie charts to show comparisons in use of feedback of scores from participants in Study 1, 2 and 3



Open Questions at the end of the Assessment

Free text boxes were provided at the end of the training session that asked the following questions:

3. Which aspects of the eLearning module did you find most useful?
4. In what ways do you think the eLearning module could be improved?

Participants comments were themed according to the responses given and relate to the subject areas of the anatomy and physiology of lactation and breast milk expression, the use of video in the training pages, the ease of use, relevance of the training content, how the training impacted on their confidence and areas for improvement.

Anatomy and physiology of lactation

Participants' comments regarding the anatomy and physiology of breastfeeding section on the eLearning are listed in Table 32. A number of participants commented on the importance of understanding the anatomy and physiology of lactation and some recognised that this was an area in which they lacked knowledge. One participant identified the importance of this knowledge in providing them with the confidence to support mothers.

Table 32. Comments on the Theme of Anatomy and Physiology

Theme	Comments
Anatomy and Physiology	<ul style="list-style-type: none">• The audio explanations along with the video for the anatomy and physiology section, as I feel this is the area that nurses need most education on.• I found the physiological side very useful to compliment what I already knew about breastfeeding.• Physiology of lactation a lot to learn but very interesting.• I found the A & P bit most useful.• Physiology behind lactation, and how to improve breast milk supply - trouble-shooting techniques.• My knowledge on the physiology and anatomy of breastfeeding it was very poor.• The anatomy because if you really understand the hormones and what happens and what can effect it, this helps you give accurate confident advice.• Learning about the anatomy and physiology aspects.• The videos - especially the video on the anatomy of the breast.

The Use of Video

Participants' comments regarding the use of video in the eLearning module are listed in Table 33. Several participants commented on how they enjoyed using the videos and found them an interesting medium through which to learn. The video demonstrating how to set up and use a breast pump was noted to be particularly informative and one user described how they

had not yet been shown how to do this. None of the participants made negative comments about the use of videos.

Table 33. Comments on the Theme of Use of Video

Theme	Comments
Use of video	<ul style="list-style-type: none"> • The videos were really good. • I found it more interesting as visual aid. • The visual demonstrations as well as the audio. • Like the video style. • Video demonstrations of hand expression video demonstrations of anatomy and physiology video demonstration of using the breast pump. • The demonstration videos - learning through watching others. • I liked the video about setting up a breast pump. • Video clips of using the breast pump correctly and how to hand express correctly. • Watching the videos was more stimulating than just reading passages. • The video demos e.g. hand expression and assembling a pump. • Watching the videos, it very useful, especially the breast-pump video. • The demonstration of how to use a breast pump-never shown how to use one before so couldn't teach women how to use them!

Relevance and ease of use

Participants' comments regarding the relevance and ease of use of the eLearning module and NUCAT assessment are listed in Table 34. All participants who chose to respond in this section were positive about their experience of using the eLearning module and the assessment tool. The content was described as 'clear and concise' and there were no concerns regarding usability highlighted. Several participants commented on how the training could be used to inform and help with their clinical practice and one participant recognised that it identified gaps in their knowledge that they wanted to improve on.

Table 34. Comments on the Theme of Relevance and Ease of Use

Theme	Comments
Relevance and ease of use	<ul style="list-style-type: none"> • Useful to know where I was going right/wrong and any advice I would give. • Very useful, it answered a lot of questions I was unsure to ask. • The step-by-step explanations and diagrams help it all make sense. • Very informative, information can be utilised to ensure mothers are being given adequate and up to date information. • I thought the module was very good and easy to comprehend. • Very useful as it can provide me with feedback to improve my practice. • Very clear and concise. • Very useful informative. • Extremely useful. Lots of helpful information. • Short chunk modules were easy to follow. • Modules were very good. • I have found it useful because I want to be pulled up on things I need to be improved upon.

Confidence

Participants' comments regarding the impact of the eLearning module on participants' confidence are listed in Table 35. Two participants commented on how they felt the eLearning module would help them to improve their confidence in clinical practice.

Table 35. Comments on the Theme of Confidence

Theme	Comments
Confidence	<ul style="list-style-type: none"> • I feel a lot more confident on how to show a mother how to hand express, as I never knew how to do it before. • Really useful I feel more confident.

Most useful information

Participants were asked to comment specifically on what they found to be the most useful aspects of the eLearning module (Table 36). These answers covered the breadth of the content of the module but focussed mainly on breast milk expression. This suggests that

although participants understood the necessity of understanding the physiology behind breastfeeding they were particularly interested in information that could support their clinical practice.

Table 36. Comments on the Theme of Most Useful Information

Theme	Comments
Most useful information	<ul style="list-style-type: none"> • First discussions with mums and what questions to ask. • I have found that the hand-expressing module most useful as it reinforces and reminds you that early interaction with parents is essential and that they can start doing something vital in those early hours when they feel most vulnerable. • Physiology, benefits of breastfeeding, methods of encouraging mothers to breast feed, hand/pump-expressing techniques. • Demonstration of hand expressing and how to use the breast pump. • Understanding how many times to express and what can inhibit milk flow. • Questions and answers afterwards. • Expression of breast milk (as that was my area of weakness in terms of knowledge, anatomy and physiology in terms of interest/knowledge). • About the storage of milk and hand expressing. • Information about hand expressing. • Facts to back up benefits of breastfeeding expectations for expression - useful for PNW. • Main point summary at end highlighting key points. • Refresher on how to set up a breast pump.

Areas for improvement

Participants were asked to comment specifically on areas of improvement that they could suggest for future versions of the eLearning module (Table 37). One participant suggested using more 'real' video footage of a mother using a breast pump. However the majority of the feedback in this section did not relate to the training content of the eLearning module but rather the NUCAT assessment. Several participants commented on the fact that they were not told which answers they got right or wrong, as they felt that this would improve their learning outcomes.

Table 37. Comments on the Theme of Areas for Improvement

Theme	Comments
Areas for improvement	<ul style="list-style-type: none"> • More videos of real people - perhaps a live video of the breast pump being used? • Simplify some of the anatomy and physiology questions • Some questions could be answered differently depending on which evidence • Need to use clearer wording to explain exactly what you are asking • Doing it at home without distractions at work • Some questions in questionnaire ambiguous • Useful to know specifically which answers you get right or wrong

7.4 Results Aim 3

To explore neonatal clinicians' experiences of undertaking the eLearning module and their opinions and experiences of supporting breastfeeding using qualitative methodology.

The population being studied were clinicians working on NICU who had undertaken the NUCAT assessment and eLearning intervention. The primary purpose of the interviews was to explore their experience of undertaking both the assessment and the eLearning module. These findings could then be interpreted in conjunction with the NUCAT assessments in order to follow up unexpected results and provide a more in depth evaluation of the user experience. Further areas explored in interview related to clinicians' experience of providing breastfeeding support and previous experience of breastfeeding training in order to further contextualise the training and explore its benefits in this setting. A purposive sampling strategy was used to obtain a sample relevant to the aims of the study. Selecting an appropriate sample that consists of participants who best represent or have knowledge of the research topic ensures efficient and effective saturation of categories, with optimal quality

data (Morse, Barrett and Mayan, 2008). Analysis of early data also guided future sampling, allowing future data collection to be responsive to the data. In total, ten neonatal clinicians consented to undertake the study according to the inclusion criteria. Face to face interviews were conducted in UHCW NICU during December 2014. The duration of interviews ranged from 18 to 41 minutes and all were undertaken within 4 weeks of the participant completing NUCAT and the eLearning module.

Characteristics of respondents

The recruitment and selection process was undertaken as outlined in Chapter Four, section 9.2. All participants who were invited to interview were given an information sheet to read (Appendix 4), they were then given a period of time (one week) to consider if they wished to take part in the study. All those who were approached agreed to take part. The only job role that was not interviewed was the ANNP, this role is undertaken by a senior nurse who has worked as a sister on NICU and is therefore similar to the sister role included in the interview group. Interviews were carried out until it was felt that themes being discussed reached saturation (Morse, Barrett and Mayan, 2008). The sample included four nursery nurses, two sisters, two staff nurses, and two junior doctors. All participants were female, from a variety of age categories, had received some breastfeeding training and had worked in NICU from 10 weeks to 12 years. The most recent breastfeeding training (within the last 2 years) ranged from a one-hour update to a full day (Table 38).

Table 38. Characteristics of participants (n=10)

Code	Job Role	Time in NICU	Last attended Breastfeeding Training	Type of training
01	Sister	8 years	2 months	1 hour update
02	Nursery Nurse	1 ½ years	1 year	1 hour update
03	Nursery Nurse	5 ½ years	6 months	1 hour update
04	Sister	3 years	4 months	1 day
05	Staff Nurse	1 year	1 year	1 day
06	Staff Nurse	3 years	2 months	1 hour update
07	Nursery Nurse	12 years	6 months	1 hour update
08	Nursery Nurse	2 years	1 year	1 hour update
09	First year Junior Doctor	10 weeks	2 months	1 hour update
10	First year Junior Doctor	10 weeks	2 months	1 hour update

Analysis

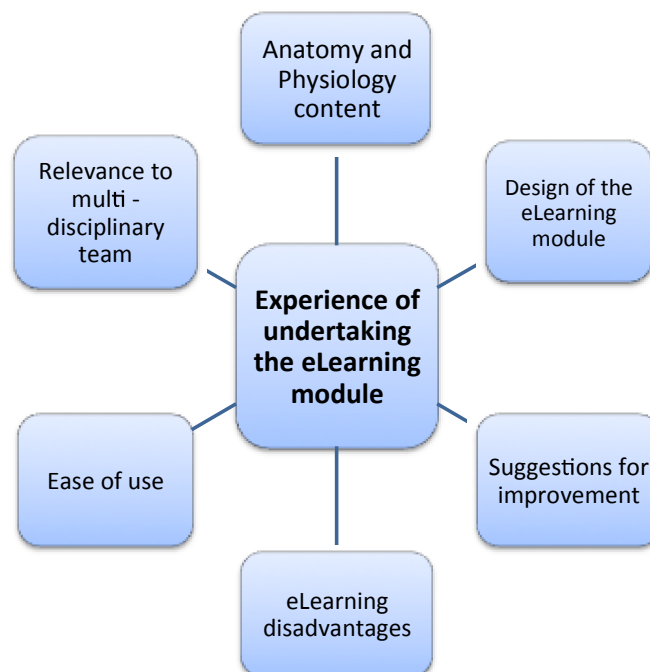
A semi structured interview schedule was used to explore current experience of breastfeeding training and provision of breastfeeding support on NICU (Appendix 6). 'A priori' issues were used to frame the interview questions (Gale et al., 2013); these encompassed four major themes: (1) The eLearning module; (2) The NUCAT assessment; (3) Supporting mothers with breastfeeding on NICU and the postnatal ward (PNW) (4) Previous breastfeeding training. The researcher transcribed all recorded interviews and read and reread all the transcripts to become familiar with the data collected. Interviews were analysed using thematic analysis

(Pope, et al. 2000). Five steps of thematic analysis were used to explore the perceptions and the detailed process of the analysis as described in Chapter 4, section 4.9. A working analytical framework was identified using codes and categories derived from the study main research questions. Further codes emerged following reading and analysis of the interview transcripts and these are identified as 'emerging codes' (Table 39). The researcher undertook all the analysis and did not have a second checker.

Table 39. Main themes emerging from the interviews

A Priori Themes	Emerging Themes
Experience of undertaking the eLearning module	Anatomy and Physiology content Relevance to multidisciplinary team Ease of use Design of the module ELearning disadvantages
Experience of undertaking the NUCAT assessment	Questions were mostly appropriate and relevant Helped to recognise gaps in knowledge
Previous experience of breastfeeding support	Need for clinical experience to build confidence Understood benefits Walking a fine line to respect mothers wishes Communication and rapport with the mother Recognised difficulties for mothers Mothers require time The need for consistent advice
Previous breastfeeding training	Useful but not always relevant to NICU Lack of anatomy and physiology of breastfeeding content Variety of training needs

Theme 1: Experience of undertaking the eLearning module



Anatomy and physiology content

All the participants said that they enjoyed the eLearning module but some found that the anatomy and physiology of lactation section quite difficult and did not feel that it was relevant information: *'I didn't like the anatomy and things like that not sure if we really needed to know. 'Cause you wouldn't really explain that to the parents'* (Sister (01), 8 years experience). Whereas other staff found it difficult but believed that it was important information for them to understand:

I think it is important to have an understanding about the way in which the body works in terms of anatomy and physiology, I think that was helpful to understand that I think it is important to understand the hormones and how they play a part in milk production and the let down of milk. (Sister (04), 3 years experience)

One junior doctor made the point that a good understanding of the anatomy and physiology of lactation provides the clinician with the necessary background knowledge to provide consistent support to mothers, and that it should therefore be the basis from which to build the training:

Both nursing and medical background should have all a good understanding of physiology. I don't know how much people absorb that though because people have different interest levels so I find that interesting but somebody else may think it's excessive, but to me it seems appropriate to know the basic physiology. Whether you retain a large amount of it or not you still have a good understanding if you are saying to mum that when you're stressed that it can effect the milk production you know what you mean when you say that. (Junior Doctor (9), 10 weeks experience)

'Relevance to multidisciplinary team'

Despite each member of the multidisciplinary team having a different level of involvement with mothers regarding breastfeeding support, it was felt that the content of the eLearning module was relevant to them all. This was for two reasons. Firstly it was important that all staff provided consistent information to avoid parents being given conflicted advice: *'Because otherwise you're not all singing of the same hymn sheet are you really? Otherwise I would feel like I could be telling doctors something, you know, and I wouldn't want to conflict with them'* (Nursery Nurse (08), 2 years experience). Secondly, it was felt by one senior nurse that parents may listen more to the advice given by one professional over another, namely medics: *'Mum will listen to the doctors more than they will listen to us, because they're the doctors'* (Sister (01), 8 years experience).

Whilst the junior doctors identified a lack in their own knowledge of breastfeeding support and understood the benefits of the training that the eLearning module offered, they were also aware that some of the information was not relevant to their practice, such as the hand and pump expression videos. Despite this, they still understood the importance of the

multidisciplinary team providing consistent advice and therefore saw the training as relevant and necessary:

I think even if you don't have a comprehensive conversation it's nice from a patient perspective the doctor can reinforce what the nurses are saying, so it may not be that I have the one on one consultation but if I know what salient points to get across, and I can say it in a brief way and that just hones in the message of breastfeeding more then as just one person saying it. (Junior Doctor (10), 10 weeks experience)

Both junior doctors that were interviewed felt that the content of the eLearning module was useful in their clinical practice, because they had already experienced situations where they know it would have been useful to have the knowledge:

Very useful it's made me more aware of the issues surrounding breastfeeding... if you're promoting breastfeeding you need to know why you're promoting it and it helped me understand a bit more, how hard it is to breastfeed as well, so encouraging mothers to breastfeed throughout the night especially in the later part of the night as well when expression is the best. Now I understand why mothers are a little bit averse to it because it's hard work, I don't think I realised it before how hard it is. (Junior Doctor (9), 10 weeks experience)

However, they did not feel that all the content was relevant to doctors as some of it focused on the practical aspects of supporting mothers with hand and pump breast milk expression:

The only thing is hands on experience but that would probably be less relevant for someone in my position because I don't directly help women with breastfeeding. I imagine things like practical sessions with how to use breast pumps although there was demonstrations on it would be more useful for nursing staff and midwives. (Junior Doctor (10), 10 weeks experience)

‘Design of the eLearning module’

A number of participants commented on the avatar that was used in the videos as something that made the module enjoyable and fun: *I thought it was quite fun with the little breastfeeding doll*’ (Junior Doctor (10), 10 weeks experience). They enjoyed the animation and found it a useful way to remember information: *I liked all the animation, the bit in the brain doing that to the boob. That was really, really good I liked the animation it was really catchy and sticks in the brain*’ (Sister (04), 3 years experience). The style of the learning was described as attention grabbing and it was noted that the variety of information on each section stopped it from becoming repetitive:

Obviously other stuff you learn on the computer you read, read, read and you lose concentration but there was so much happening it kept your attention. (Staff Nurse (05), 1 years experience)

All the participants described how they enjoyed watching the videos as a method of learning. Some described themselves as visual learners and felt that this suited their learning style: *‘Yes I am more a visual person... it works better than just reading through’* (Staff Nurse (05), 1 years experience). Whilst they all enjoyed it some felt that it would serve as a good adjunct to other forms of training or even multiple forms of training. This links in with previous comments that describe the importance of clinical experience in training, and further reinforces the place of eLearning as one of many successful forms of delivering breastfeeding education:

I like being taught different information in different ways, obviously classroom based UNICEF day and then having the e-learning and a log book that you can download and perhaps have a one to one if there is something that you were not sure about sit with some one who knows about breast feeding or who is more experienced with it ... I think that when you are just listening to how somebody else teaches that’s just another way of learning for you. So for me to go and sit with the breastfeeding advisor and a mum would actually enhance my learning as well so actually I think

that it needs to be done in a variety of ways rather than just one. (Sister (04), 3 years experience)

The eLearning module included a video that showed a member of staff performing a practical demonstration of how to assemble the breast pump that mothers used on NICU. Several participants remarked on how useful they found this short video. This was either because they had not previously been shown how to assemble and use the breast pump or because since being shown they had not had to assemble the pump and had therefore forgotten how to do it. The use of a video to enable the user to spend time repeating aspects of the instruction was seen as helpful:

Because I hadn't really been shown properly how to use the pumps but on the video, yeah that was really useful being taught through that because I knew it had the premi setting and the standard setting but they did go over that quite, they sort of breezed over that in the UNICEF thing as if everybody sort of knew how to use the pump and when your sort of new you don't like to say well actually can you show me individually. (Nursery Nurse (08), 2 years experience)

Participants described how they found the layout of the webpage user friendly and easy to navigate. They particularly liked the fact that they could access the training material at their own pace and had the ability to revisit information:

It was very clearly laid out and I liked the chapters and how you could go back to and listen back to things like some of the more complicated chapters like the hormonal reflexes were quite good so like to go back to like that again and it was all quite interestingly clearly laid out' (Junior Doctor (10), 10 weeks experience)

I went back on a few things and I think that it was good that you could go back and re-visit the slides so that I did understand a lot clearer and drum them in to my head but that's the way that I work. (Staff Nurse (06), 3 years experience)

‘Ease of use’

None of those interviewed had any technical difficulties accessing the training pages or undertaking the NUCAT assessment and described how they enjoyed the design of the training: *‘yeah I really liked it - it was clear, concise really well designed very modern looking and worked well so there was no technical problems either’* (Junior Doctor (9), 10 weeks experience). Even those who expressed concerns with using eLearning found it accessible and straightforward: *‘I’m not very confident no, but I did find that was okay. At first I thought oh computers but actually once you’re on the site it was quite easy to use and that’*. (Nursery Nurse (08), 2 years experience)

A number of the participants decided to undertake the eLearning module in their own time at home. One nursery nurse described how she preferred to learn at her own pace and felt that eLearning was difficult to undertake in a group situation, where she would be expected to learn at the same pace as those around her:

I did it at home. I don’t really go on the computers here very well. I like to do it in my own time. I’m not very good sitting in a group like they do the e-learning here sometimes when you have the study days. I feel under pressure to read it faster than I like, it’s probably me being really slow. (Nursery Nurse (08), 2 years experience)

Other participants chose to do it at home because although there were computers in the work environment, they did not have protected time to undertake the eLearning module, and felt more comfortable in their home environment without the pressure of being at work and having to rush the training and assessment.

‘eLearning disadvantages’

Some participants identified disadvantages with eLearning. One senior nurse felt that face to face training had the advantage of being able to raise questions and challenge the learning content: *‘You can interact and ask different questions where as on a computer it’s more about what the computer is going to tell you, you can’t just question it’* (Sister (01), 8 years experience). Another believed that more practically based, clinical teaching was better suited to their style of learning, particularly when they felt that their previous clinical experience had not touched on the subject matter:

I think with breastfeeding and with teaching mums how to hand express, I think it’s a bit clinical when you are learning from a video, I think that personally my own perspective I would have preferred to have learnt from another practitioner along side a mum. Personally, I think because I haven’t come from a paediatric background I haven’t had that exposure so I think I would have preferred that sort of exposure. (Sister (04), 3 years experience)

However, others recognised that eLearning could be used to support practical experience. This was because eLearning provided a good educational basis for developing clinical skills and this theoretical knowledge helped to reinforce confidence in the work place:

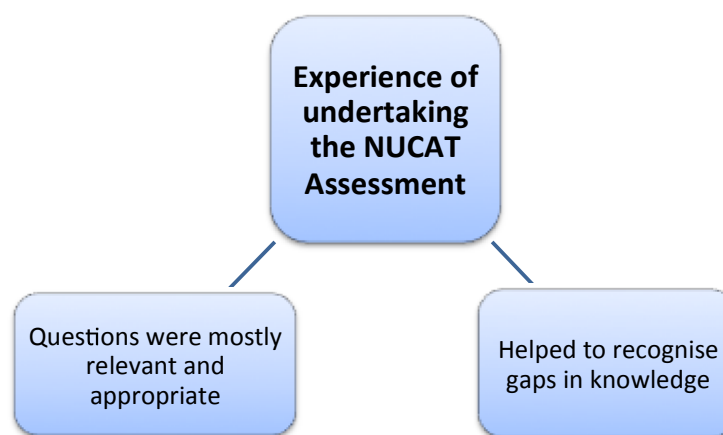
I think being hands on is the main thing and having the time and access to patients ready to be shown that goes hand in hand with the eLearning. I think the eLearning is a good starting point to then go to feeling confident to talk to a parent and get them on board and show them. (Staff Nurse (06), 3 years experience)

‘Suggestions for Improvement’

Suggestions for improvement included more written text during the video, for those who had difficulties with hearing, recapping the information at the end of each module and including mini tests within the eLearning module itself. Participants believed that the eLearning module

should be made freely available in order that staff could access training at any time, including from home. Future areas of training identified by staff related to monitoring on-going breastfeeding support, ensuring that mothers are managing to maintain their milk outputs and ensuring they are given full support to achieve breastfeeding on discharge from NICU.

Theme 2: Experience of undertaking NUCAT assessment



‘Questions were mostly relevant and appropriate’

Whilst some of those interviewed found the NUCAT questions relating to the anatomy and physiology of lactation quite difficult, they also recognised that it was useful to identify areas of knowledge that could be improved as well as those areas where improvements had been made: *‘At first I found some of the questions difficult, to do with the physiology, but I found them really useful, I found I know a lot from that part of the studies. So I found it difficult but very, very useful’* (Nursery Nurse (03), 5 ½ years experience). Also the number of questions that were included in the test was described as appropriate for the training exercise: *‘It was not like it was a very comprehensive, long-winded quiz, it wasn’t excessive,*

and it was quite to the point' (Junior Doctor (10), 10 weeks experience). The style of questions asked was also regarded as relevant to clinical practice:

I did feel like they were appropriate questions because that's what the parents want to know, they want to know about where the milk is stored about the best way to do it and I think the questions get the back ground knowledge so that you can explain to parents why you're doing hand massage. (Staff Nurse (06), 3 years experience)

'Helped to recognise gaps in knowledge'

The NUCAT assessment was seen as beneficial as it provided participants with an insight into how much they had learnt and this instilled a sense of personal growth: *'I liked the fact that you do a quiz pre and post that's always a nice way of measuring how much you've grown in your knowledge'* (Junior Doctor (9), 10 weeks experience). Several of the participants were disappointed that they were not told which questions they got wrong in the NUCAT assessment. It was explained to them that this was because NUCAT was used as part of a study and this was not therefore possible.

The benefits of the NUCAT pre and post assessment included informing the clinician of areas in which they needed to improve their knowledge as well as providing them with evidence of their own learning and improvement. One participant described this sense of achievement as a positive experience that they believed enabled them to feel more confident in their clinical care:

I did like the fact that you did a pre and post course questionnaire. I found it really interesting, because although I have just done the UNICEF breastfeeding course I only got 65% in the first part but then it was really good to have the course and at the end get a better result, I got 80% so it was good to see that I had improved and it made me more positive about spending the time doing it and I have learnt something and it is a positive experience and I can go on forward. (Staff Nurse (06), 3 years experience)

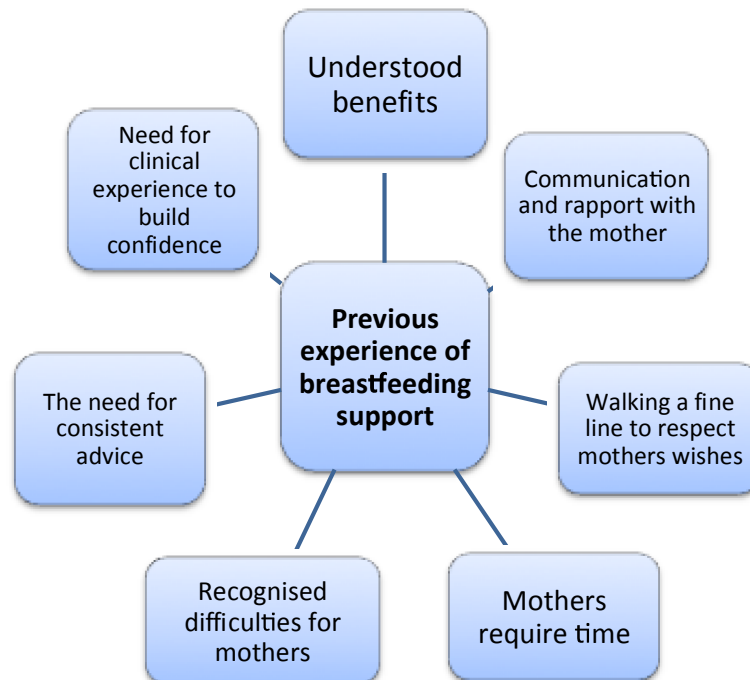
A nursery nurse described how undertaking the eLearning module and assessment helped to reinforce their confidence when providing advice because they believed they understood the rationale behind the guidance they were giving:

Yes so I feel can talk to mums about that now and even if mum is saying no she isn't getting anything I can say well actually the baby is there and having a go and it's all helping you make the milk, so I feel more confident in talking to the mums about that sort of thing. (Nursery Nurse (08), 2 years experience)

Participants identified a role for the eLearning as a 'good refresher' to support other breastfeeding education and their on going professional development:

...I found it a really good refresher, I think It's something that should be introduced so that people could use it again to refresh their memories. It's something that you could forget if you don't do it for a while so that was helpful. (Nursery Nurse (03), 5 1/2 years experience)

Theme 3: Previous experience of breastfeeding support



‘Need for clinical experience to build confidence’

The nursery nurses that were interviewed described the importance of clinical experience, alongside education, in building their confidence. One nursery nurse indicated that the training she had received had not suited her style of learning and she recognised its limitations with regards to meeting her learning needs.

I think it was half day training but that was in a big group. So it was the first time I had ever done it and it was quite hard to take it in really and it wasn't sort of one to one training. It got the basics but not really. Its more because I'm more of a hands on person really I suppose. I find it much more useful watching other nursery nurses or other staff talking to the parents and watching that as everyone is different aren't they'. (Nursery Nurse (08), 2 years experience).

Another nursery nurse described how she lacked confidence in supporting a mother to breast milk express by hand, as she felt that it was a skill that she had seldom supported: *'I could feel more confident; I don't feel overly confident with it because I don't think we do it very often on special care'* (Nursery Nurse (02), 1 ½ years experience). Shyness was also an issue for one nursery nurse who felt that this may impede her ability to provide support:

Yea I think I have got the knowledge to do it but personally I'm quite shy and I think I would find it really difficult. I would probably be a little worried that I might say something wrong. (Nursery Nurse (03), 5 ½ years experience)

However, whilst clinical experience was important, the need to balance it with formal education was identified by one nursery nurse who described how substituting clinical experience for training was insufficient to tackle the problem of confidence: *'It's just learning as you go which then obviously if you're not 100% confident with it, it's not that great'* (Nursery Nurse (07), 12 years experience).

Nursery nurses described how they believed they were seen as key member of the workforce regarding breastfeeding support: *'We are the first port of call, and obviously they come to find a nursery nurse to do all of this, so you need to know'* (Nursery Nurse (07), 12 years experience). However, she went on to express her concern that she did not always feel fully confident in the advice she gave: *'I would second-guess what I'm saying quite a lot and come away and think have I done it right but that's probably just me as a person'* (Nursery Nurse (07), 12 years experience). A less experienced nursery nurse, who was not always confident in their knowledge and abilities to support mothers, reiterated this sentiment: *'they do say 'she is a nursery nurse, go and talk to her'. It's quite nice in a way that people do think that but it would be nice to know more myself I suppose'*. (Nursery Nurse (08), 2 years experience)

Other participants, who described how through gaining experience they gained confidence, identified the role that clinical experience plays in improving staff confidence. This highlighted

the need to support juniors who may avoid interaction with mothers due to their own anxieties and inexperience.

I found it easier once they came from special care because they were a bit more confident with the baby themselves. But the more I do it the more confident I am. Its one of those things I get really nervous about but again I think that's just because I haven't done it myself so I don't know what the best way is apart from reading a text book to see. (Staff Nurse (05), 1 years experience)

'Understood the benefits of breastfeeding'

Participants understood the benefits of breastfeeding and recognised the important role it can play in empowering the mother, enabling her to: '*feel like she is really providing the baby with everything it needs*' (Nursery nurse (03), 5 ½ years experience). Bonding is seen as a key positive outcome of breastfeeding as it enables the mother to participate in her baby's care, and by doing so creating 'normality' in an environment in which conventional mothering is very difficult to provide. It is recognised that fathers also find the process of bonding and being involved with their baby a challenge on NICU, and that breastfeeding can help through engaging the father in supporting the mother:

I think that the bonding side of things, I think that mum feels that she is doing something normal for baby. I suppose it could be more difficult for dad as mum has that connection with feeding but I suppose it's good that they are both involved with dad supporting mum and mum supporting baby. (Staff nurse (06), 3 years experience)

One junior doctor described how it could help the mother with feelings of hopelessness, as it encourages active involvement when they cannot hold or cuddle their child:

Immunity is a key one, helping bonding especially if there is often no real reasons like especially when they are in incubators, its quite difficult for mums to produce those bonds with their babies especially if they are not able to hold them or cuddle

them or anything. So it also helps get mum involved because it means that she can help with something by helping to produce her milk, where otherwise parents can feel hopeless on the unit. (Junior Doctor (9), 10 weeks experience)

Participants also described the physical health benefits of breastfeeding, and in particular in association with necrotising enterocolitis and the preterm gut. However, much of the discussion focused on the psychological benefits that breastfeeding can bring about how it can help a mother to focus on this positive aspect of their baby's care, thereby potentially reducing her feelings of anxiety:

I think that expressing is such a good thing for the mother's psychological well being and coping with a premature baby. They think 'oh my god I don't know what is going to happen here' and it's the one thing that they are in control of. (Sister (04), 3 years experience)

'Mothers require time'

Participants recognised that mothers required time and support to both initiate and maintain breastexpression, and that the first consultation was key to ensuring mothers felt able to talk about the subject and express their anxieties and concerns:

I think a lot of it is just listening to them and they come across quite relieved that you are talking about it because no one else has... they talk about breast feeding and expression they are relieved that we are bringing up the subject from the start'. (Staff Nurse (06), 3 years experience).

Participants also understood that this process was not necessarily straightforward and that taking time to engage with mothers, and offering even simple support and advice could impact on their ability to succeed:

I think that from the feedback that I get from mums they really appreciate that 15-20 minutes one on one with them going through massaging the breast, talking to them

about it, showing them how to find the change in tissue, showing them where to put the C, what they are going to get, how to catch the milk. That whole process they are really appreciative of. I had one mum who said I think I have all of it but I can't catch the milk, I can't catch it. So I ended up sitting with her and I did the catching the milk bit and then mum did the next time and by the 3rd time she's done it all. I think there's a bit of continual education with the mum. (Sister (04), 3 years experience)

The timing of advice was also noted to be an important aspect of providing support, both ensuring that it is given shortly after the delivery of the baby and also at a time that is sensitive to the needs of the parents:

Some parents are not interested and are focused on getting their baby better. They do want to know but it's not the most important thing at that time. So I think it's picking your time when is best and asking if you want to breast feed and express and if they say yes but I want to do it later its taking a step back and letting them guide. (Staff Nurse (06), 3 years experience)

However, participants also noted that the ability to provide support is affected by staffing levels because a lack of staff may lead to constraints on the amount of time they can spend with the mother as their primary care is focused on the baby: *'I suppose the only thing that is difficult is staffing and time restrictions if you're so busy'* (Sister (01), 8 years experience).

The time that mothers need to establish breastfeeding was also noted to impact on the mother's decision to continue with breastfeeding. This combined with the pressure for cot spaces in a busy tertiary unit can have detrimental effects on breastfeeding outcomes:

If a mum needs more time to establish breast feeding she should be given it, however there is a lot of pressure on beds, a lot of pressure on getting parents out with babies, and I think that to a mum who is desperate to get her child home, that if you're told actually if you start bottle feeding this child they will be home faster some mums actually well hey, hang on a minute I want my baby home, I think I will. I think this is where the discrepancy comes in. (Sister (04), 3 years experience)

‘Walking a fine line to respect the mothers’ wishes’

Parents’ decision to breastfeed is considered to be a sensitive area, as clinicians both want to support them in their decision but enable them to make an informed choice. One nursery nurse describes this process as *‘walking a fine line to respect their wishes’* (Nursery Nurse (08), 2 years experience). Participants recognised the importance of not pressuring mothers in their decision to breastfeed, despite being very pro active in supporting breastfeeding: *‘I think we are trained to push breastfeeding as much as we can without making mum feel pressured in to doing it’* (Staff Nurse (05), 1 years experience). Another senior member of staff recognised that it is the mother who should lead on the degree of support they wished to receive and believed that it was the clinician’s role to respect the mother’s choice to bottle feed whilst ensuring they are provided with adequate support and information to inform that decision:

I think there is always that underline feeling of ‘well you can do both’ you can mix feed, but ultimately you have to respect the parents choice... if a mum says I do not want to breast feed and I’m not interested and nothing you can do can change my mind, then fair enough I’m not going to tell her you have to breast feed because that’s not going to help her. But if you have a mum who is not sure then that is the time when we step in and give her all that time and that information and say that we are here for you and to support. (Sister (01), 8 years experience)

One participant described the importance of carefully wording their advice and support and recognised the need for sensitivity when approaching mothers who have very sick infants:

You just have to word it very carefully; if they have had bad news you wouldn’t go in and say can you please express now? But I think it’s being tactful and thinking about the words you use and when the right moment is to introduce hand expression and expressing in the early days. (Staff Nurse (06), 3 years experience)

This sensitivity is also described as important in order to ensure that a mother does not feel despondent when they are struggling to provide breast milk. It should be recognised that mothers need encouragement but are also supported in their decisions, and not made to feel guilty if they are either unable or do not want to provide breast milk:

Obviously it's not about making them feel down if they can't provide the milk or they haven't got enough or it's not come in yet. It's about making it positive and saying it will come in, and if you do want to do it or not then not being down if they don't want to breast feed or express, or if they are only trying to do it for the short term.
(Staff Nurse (06), 3 years experience)

'Communication and rapport with the mother'

A majority of the participants described communication as a key aspect in ensuring a mother was receiving the necessary support to perform breast milk expression. It was noted that there were occasions where the NICU staff believed that the postnatal ward (PNW) midwives were leading on advice and support and vice versa, and in this instance a mother may miss out on the necessary care:

I think it's really by communicating with the parent. They can be missed by upstairs and missed by us, I think the parents are regularly down here with their babies, doing cares with their babies and I think its important as a nurse to ask them daily how its going and how is expression doing and I think from me I always ask them everyday how they are doing even if I know they were expressing well yesterday they maybe having a bad day today. (Staff Nurse (06), 3 years experience)

Some participants believed that better communication between NICU and PNW could further support mothers with breast milk expression. The failure to communicate effectively can result in a lack of consistency in support, and mothers can be 'lost' in a system where one health care provider may believe that the other is providing the help:

I think that when mums are seen in our domain they are our mums. Some will say actually my midwife was really helpful she came to me straight away with expressing showed me how to hand express, I'd say oh great would you like me to go over it and they say yes please or no I'm happy. Some mums will come and say I've had absolutely nothing no one told me about hand expressing or anything this is the first time its been mentioned. It's hit and miss. (Sister (04), 3 years experience)

Further to the importance of communicating with the mother, participants noted that they needed to form a relationship with the mother in order to enable them to be able to provide support. Some participants described how building a good rapport and feeling confident in approaching mothers was challenging. However, once this bond was established then communication was more comfortable and the ability to support a mother became a smoother process:

I think it's hard when you don't know a family very well and you are having to help them latch the baby on when its quite a personal thing if you haven't got a bond with that parent, so you have to get the bond first before you sit there. Once you build that bond as offering to help, then they are more likely to approach you the next time. (Nursery Nurse (02), 1½ years experience)

It depends on your rapport and how well you know the mum, I think it's quite difficult sometimes. If you're just thrown in there and don't have that rapport with the mum but if you do, then you feel yeah I could tell her the basics. (Nursery Nurse (08), 2 years experience)

'Recognised difficulties for mothers'

Participants recognised that mothers faced a number of difficulties when trying to breastfeed their sick infants, and that in order for them to be successful they required a lot of support and encouragement:

I think that the shock of having a premature baby and everything that that entails, they need us to help and support them and educate them and congratulate them all

the time you know, well done that's fantastic you've got a ml of milk you know really cause they love it and they're like oh thank you. (Sister (04), 3 years experience)

They understood the pressures on mothers who already had young children at home, and who may have found spending long stretches of time on NICU difficult because they could not find childcare for their other children:

I fully support breastfeeding and I think it's great for a pre-term baby and a sick baby. But when you've got a special care baby and you have got other children and family life I think it impacts here the unit, as in a mum can't be here 24 hours a day to try and establish breastfeeding and be here on the unit as well as care for other children at home. (Nursery Nurse (07), 12 years experience)

One nursery nurse described the challenge that mothers face when trying to breastfeed their child to the point of discharge from NICU. They identified that during this period the mother may be susceptible to believing that it might be 'easier' to bottle-feed, and that if they did this could result in an earlier discharge:

I think the only problem you get is when you see babies going home first and they're bottle feeding, bottle feeders tend to go home before breast feeders and I think some mums pick up on that sometimes and they're like 'shall we just do the bottle?' (Nursery Nurse (02), 1½ years experience)

It was also recognised that mothers may be influenced by the behaviour of other mothers on the unit. A sister described how once babies had graduated to the special care part of the nursery, then it was possible that the culture in that part of the unit did not fit with supporting breastfeeding in the same way as it did in an environment where mothers were all expressing milk:

I think that it's certainly more in the special care situation, in intensive care and high dependency ... the mums are all pumping and if they are in an environment where they see each other doing it, it really spurs them on. When you get up into special care, you've got mixed feeding, some mums are starting to use the bottle, you've got

term babies in there as well whose mums have decided that they are not going to breast feed at all and they are going to bottle feed and I just think it gets lost up there. (Sister (04), 3 years experience)

One staff nurse described how the challenge for mothers to breastfeed increased as their babies got better and moved from intensive care to the special care nursery, where they were predominantly receiving milk feeds. They recognised that these mothers may require specialist support from the extended breastfeeding support team:

Later on when its hard and mum is struggling to keep supply up and I think that you are getting to the point when you have explained the pump explained the benefits and they are expressing 3-4 hours and still not getting enough and the baby is sort of being held back in a way and I think people do give up quite early and say to mum well lets try bottle feeding where I would take a difference stance and say lets try and get the breast feeding person in to see if there is another way to think of that. (Staff Nurse (06), 3 years experience)

‘The need for consistent advice’

The need for the multidisciplinary team to work together to provide consistent advice was recognised by participants and the failure for this to happen was cited as a possible reason for difficulties with supporting mothers: *‘I think that one of the problems that we have got is that sometimes the medical team are not on board with the nursing team’* (Sister (04), 3 years experience). One experienced member of staff, felt that mothers may be more inclined to listen to advice from the medical staff and felt despondent when advice had been given to mothers that contradicted the support that they themselves had provided, particularly when this had led to mothers changing their minds about continuing with fully breastfeeding:

Well we're talking to mums and really going through how it benefits and all that and then doctors come round and say one thing like maybe you could just give it a bottle

and mum will listen to the doctors more than they will listen to us because they're the doctors. (Sister (01), 8 years experience).

One junior doctor described the importance of providing consistent information and understood the important role that they could play in reinforcing nursing decisions

I think even if you don't have a comprehensive conversation it's nice from a patient perspective the doctor can reinforce what the nurses are saying, so it may not be that I have the one on one consultation but if I know what salient points to get across and I can say it in a brief way and that just hones in the message of breastfeeding more than as just one person saying it. (Junior Doctor (9), 10 weeks experience)

The need for consistency amongst staff was understood by a number of participants who recognised that attitudes towards support had an impact on the mother's success. However, watching other clinicians in practice can lead to inconsistent information or advice being given, as participants identified the fact that individuals may have differing opinions and practices: *'Yes some people do say different things from others, so it is useful to having I suppose the background knowledge'* (Nursery Nurse (08), 2 years experience).

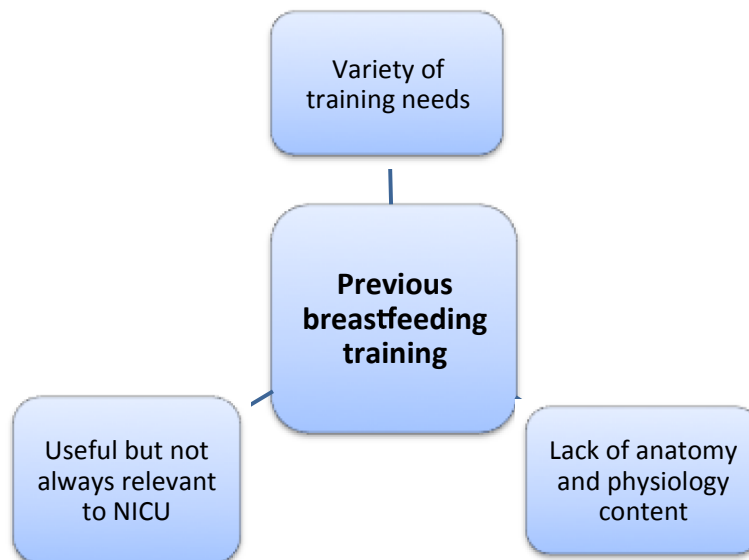
One participant recognised that staff did not always monitor the amount of milk a mother produced.

Once you have got passed the initial few days, it's kind of like, well this mum is expressing and its not on the radar anymore because she's just expressing the milk, coming in and putting it in the fridge, putting it in the freezer and really you have no idea about that quantity at all as a nurse because if you see some one bringing in an EBM and its feeding a baby job done you know your work is done kind of thing. (Sister (04), 3 years experience)

Other staff felt more positive about the unit culture though they recognised that not all staff had the same degree of positivity towards breastfeeding:

There are some individuals who can be negative but I think that everyone does the same things in the early days... I do think that we all lead to the same conclusion and the same culture.' (Staff Nurse (06), 3 years experience)

Theme 4: Experience of previous breastfeeding training



‘Useful but not always relevant to NICU’

All of the participants had received mandatory breastfeeding training, according to Trust policy, and this had been delivered by the breastfeeding lead for Midwifery using UNICEF training materials. The training session varied from a one-hour update to a half or full day teaching programme. The majority of participants described their previous experience of breastfeeding training as a useful introduction to the subject, especially if they had no previous experience working with breastfeeding mothers or breastfeeding themselves:

It was useful but I think it's a lot to take in when you first start. And when you've not really been through it yourself, so you don't really know how to support someone, so

I think it would be really good to have some sort of refresher. But there was a lot of useful information. (Staff Nurse (05), 1 years experience)

The whole day one was very useful. I learnt a lot about the background of breastfeeding I've breastfed myself, but it's different when you kind of know the theory that goes along with it so yeah very useful. (Nursery Nurse (08), 2 years experience)

However, some found that it lacked relevance to their work with preterm and sick babies and this caused frustration, and left them feeling that they required further specialist training:

I felt there were gaps in knowledge for neonatal babies, a lot of it especially the UNICEF stuff, was aimed at term babies and although the trainer did try and provide examples for neonatal babies I did find that a lot of the stuff they were giving examples for we don't actually use on the unit. (Staff Nurse (06), 3 years experience)

'Lack of anatomy and physiology content'

In particular, the knowledge concerning the anatomy and physiology of lactation was noted to be lacking in previous training sessions, compared with the eLearning module:

The UNICEF training I think that there wasn't enough information along the line of some of the things that were discussed in the eLearning module, like the hormones and the let down reflex. I don't think they went through that in enough detail, some of those aspects they could have gone over a little bit more. (Sister (04), 3 years experience)

One nursery nurse described how it was in this area of knowledge that she felt she needed more educational support:

Actually I'm quite happy talking to the parents and helping them with positioning and that but I don't know so much of the background of the way it works. Yeah that's the bit that I struggle with sort of to be able to explain to the parents about why and

what the mechanics of it and that sort of thing. (Nursery Nurse (08), 2 years experience)

‘Variety of training needs’

Participants understood the importance of regular updates and training but one nursery nurse felt that the current amount of training that they received was not adequate:

I don't think a course, a full day UNICEF breastfeeding course once every 5 years is enough knowledge, various things changing all the time and mandatory training day for an hour once a year is not enough. (Nursery Nurse (07), 12 years experience)

Another nursery nurse felt that the training she had received had not given her the confidence to go out and practice: *‘It gave me a start. I’m still trying to leave it to the more experience staff I think’* (Nursery Nurse (08), 2 years experience). Whilst a staff nurse believed that it was more the style of training that they would prefer rather than the length of time spent doing it:

I think the yearly update on line would be really helpful and it something that I would probably enjoy doing rather than doing a whole day or whole afternoon in a room talking about expression and hand expressing. (Staff Nurse (06), 3 years experience)

The junior doctors that were interviewed had received mandatory training at the start of their placement but described this session as lasting for one hour and not providing information that would help them to make clinical decisions:

We had some breastfeeding training as part of our introduction on NICU which talked a lot about the importance of breastfeeding but then not really how we go about providing that help, if that makes sense. (Junior Doctor (10), 10 weeks experience)

Both doctors recalled their experience of breastfeeding training in medical school as focused on the benefits of breastfeeding and the anatomy and physiology of lactation rather than the practical aspects of how to give advice to mothers:

We didn't even get training in medical school really about breastfeeding, apart from it's good thing. Before this (eLearning module), I felt unable to provide much help apart from to say breastfeeding is a good thing and to speak to your midwife if you have any concerns. I mean even when I had relatives ask more about breastfeeding I wasn't really able to give any information because I didn't know anything. '(Junior Doctor (10), 10 weeks experience)

7.5 Discussion

The third version of the eLearning module evaluated well on user feedback. A majority of the participants found it easy to use and did not experience any technical difficulties. The length of time taken to complete the module indicated that users were engaged in the process of learning. None of those interviewed had any technical difficulties accessing the training pages or undertaking the NUCAT assessment. The avatar that was used to deliver the content of the training module evaluated well. Another study that developed eLearning for nurses described how users commented that in certain situations they prefer watching avatars to real people (Wood 2010). Participants described how it made learning more interesting and fun, and they found it engaging. The use of short videos to deliver the learning content also evaluated well and was seen as particularly useful because it allowed the participants to control the speed at which they learnt, and to repeat sections they felt they had not fully understood the first time. Other studies have also evaluated the use of video in eLearning positively (Gerdprasert, 2010).

Undertaking the NUCAT assessment was seen as a useful exercise because it helped participants to identify areas of knowledge weakness. The subject area of anatomy and

physiology of lactation was recognised as being more difficult in interviews and knowledge scores both at baseline and post intervention verified this. Whilst users identified no particular questions as being too difficult findings from NUCAT item analysis indicated that questions relating to the feedback inhibitor of lactation were particularly challenging. Question feedback served to illustrate the variety in clinicians' understanding of the anatomy and physiology of lactation and supporting breast milk expression on NICU. This diversity of opinion and knowledge can lead to mothers being given a range of advice that could result in confusion (Jaeger et al. 1997; Flacking et al. 2006; Edmunds and Nevill 2008) and therefore highlights the need for all staff to provide accurate and consistent information.

Interviews revealed that previous breastfeeding training had not necessarily covered the subject area of the anatomy and physiology of lactation and this could account for the low participant baseline NUCAT scores for this subject. All participants felt that training in breastfeeding support was relevant to their role. Junior doctors made the point that some of the content in the eLearning module referred to practical areas of support that they would not be involved in. However, they recognised that by understanding the practices of all members of the team it was possible to provide consistent information to mothers.

Participants' understood the benefits of breastfeeding to mothers and babies and had a clear understanding of the difficulties that mothers experience on NICU. This further supported their recognition of the need for training. They described how providing initial support and advice to a mother may be challenging. This was an important finding because it was a focal aspect of the training content in the eLearning module. They described how they understood the importance of encouraging breastfeeding without wanting to be seen as pressurising mothers. Identifying the right time to approach a mother and knowing what to say are key elements of supporting breastfeeding on NICU (Meier et al. 2007) and whilst this aspect of the eLearning module was not evaluated in the NUCAT assessment it was included in the training in order to contextualise the learning content and make it applicable to clinical scenarios. Communication was also recognised as a key aspect of breastfeeding support,

both between clinicians and mothers and between the staff themselves. Participants understood the importance of multidisciplinary training in order to provide consistent information to mothers on NICU. The importance of all clinicians providing consistent advice was highlighted by participants who felt that parents may be more influenced by what they regard as a more senior opinion, in this case that meant the medical team.

Nursery nurses total confidence and total knowledge scores increased the least out of all the job role groups and they had lower baseline confidence in knowledge and confidence in practice scores than neonatal nurses. When interviewed, nursery nurses felt that whilst they were seen as experts, providing a good deal of the breastfeeding support on NICU, they did not necessarily feel that they were specialists in terms of their knowledge. One nursery nurse described how they felt that clinical experience was integral to breastfeeding training, however they did not see it as a substitute for formal training, rather it was recognised that both were needed. This may suggest nursery nurses could benefit from further training to support the eLearning intervention. This could take the form of blended learning whereby breastfeeding educators in clinical practice would further support the eLearning module content.

The interview study findings suggested that eLearning could support increased access to training materials. A number of participants were prepared to undertake the eLearning at home and even preferred this to doing it in a work environment, as it allowed them to take their time and not feel that they were in a situation where they were being observed or compared to others. Whilst working at home should not be expected of clinicians this does indicate that making training freely available increases access and allows individuals to undertake training in their own time if they wish to do so. A further advantage of the design of the eLearning module was that it was possible to select particular videos that seemed most suited to the individual's learning needs. Therefore, whilst doctors noted that not all the content in the training module was directly relevant to their practice, they had the option to select learning material that they felt was most relevant.

It was also interesting to note that the doctor/ANNP group was identified as those whose confidence increased the most following the eLearning intervention.

The inability to ask questions was cited as a disadvantage by some participants and this finding is supported by the literature (WHO 2015). However other issues such as eLearning being more time-consuming, feelings of isolation and lack of in-depth group discussion that are cited by WHO (2015) were not identified in this study. This is likely because the eLearning module is concise and comprehensive and may be well suited to training in this context. Comparisons to the literature review in (Chapter Two, Section 3) could not be made because none of these studies interviewed participants regarding their experience of undertaking the training intervention or assessment.

7.6 Chapter summary

This chapter described the results from the qualitative evaluation of Version Three of the eLearning module. Participant feedback was generally very positive with no experience of user issues affecting the accessibility of the training. Further to this users enjoyed the video format that delivered the educational material and in particular videos that provided guidance on clinical skills, such as demonstrating how to use a breast pump. Interview findings suggested that the eLearning was a good multidisciplinary tool and that the subject area of anatomy and physiology of lactation was an important part of the breastfeeding training syllabus. Nursery nurse expressed some concerns about their confidence regarding their position as breastfeeding 'experts' and welcomed the opportunity for further training.

Chapter 8 – General Discussion

8.1 Introduction

This chapter will discuss the key findings from the thesis and interpret the results in relation to the wider literature. A discussion of the strengths and weaknesses of the study will also be reported. The chapter will conclude by identifying the contribution this thesis makes to the literature, with suggestions for future research.

The unique contribution of this study was to develop an eLearning module for neonatal clinicians to enhance their knowledge and confidence in supporting mothers with breastfeeding on NICU using educational design theory. This educational intervention was unique because it was designed for web based delivery in order that it could be integrated within the NUCAT e portal. The benefit of using this design was that it allowed clinicians to access a single site in order to complete an assessment, evaluate their training needs, undertake the training module and then repeat their assessment to see if they had achieved their learning outcomes. In order to evaluate the eLearning module, a previously validated instrument, the NUCAT assessment tool, was used to measure knowledge and confidence. Using NUCAT allowed comparison of results to a previous study using the same instrument (Wallace et al 2013). Whilst this instrument required some adaptation, this is preferable to using an existing instrument that is not well suited to the study (Reed, 2005).

8.2 Summary of Results

8.2.1 Research Question One

What makes an effective eLearning module for clinicians to support breastfeeding in NICU?

Study One evaluated the first iteration of the eLearning module (Version One). NUCAT assessment results did not show improvement in knowledge and confidence in all areas tested. Total knowledge, knowledge in breast milk expression and total confidence did not show a significant improvement, however there was a significant improvement in knowledge in the subject area of the anatomy and physiology of lactation. NUCAT question analysis was performed in order to eliminate ambiguous or misleading items and identify specific areas of course content that may need greater emphasis or clarity. Item analysis of NUCAT questions identified several questions that either did not effectively assess knowledge or were technically problematic. User experience identified technical issues with the platform that was used to deliver the learning content. The challenges that were identified were addressed by undertaking several design action steps.

Study Two evaluated the second iteration of the eLearning module (Version Two). NUCAT assessment showed a statistically significant improvement across all areas including total confidence, total knowledge, knowledge in the anatomy and physiology of lactation and knowledge in breast milk expression. Baseline scores were also higher in this study than those in Study One. This could have resulted from users being more motivated to engage in the training or from being a more knowledgeable group. Study Two did not identify any major concerns with the content of the eLearning module. A further two NUCAT question items were identified that required replacement in order to ensure the assessment accurately measured learning outcomes. The Table of key design principles outlines the significant changes that were made as a result of both studies (Table 40)

Table 40. Table of key design principles

- The use of avatars to present information
- The use of instructional videos to present practical training information
- The use of video 'nuggets' presenting information in 3-4 minutes
- Written information visually presented with audio
- Ensure professional standards of production
- Ability to control videos so that they can be replayed repeatedly
- Simple web based design with no external links to avoid streaming difficulties
- Provide written information to complement all learning material

8.2.2 Research Question Two

1. Is eLearning an effective way to improve the knowledge and confidence of clinicians to support breastfeeding practices in NICU in two areas of knowledge:
The anatomy and physiology of lactation
Breast milk expression

Study Three reported the final evaluation of version 3 of the eLearning module. Results indicated that participant knowledge and confidence increased immediately post intervention and did not significantly decrease at 6-8 weeks. Participants knew more about breast milk expression than they did about the anatomy and physiology of lactation. However, user feedback indicated that participants enjoyed the anatomy and physiology of lactation training information and felt that it was an important part of the training syllabus. Additionally, the results revealed that there were differences in breastfeeding knowledge and confidence

across groups. Doctors and ANNPs, those in the 'over 40' age group, those who had worked on NICU for longer than 5 years and spent more time caring for babies had higher pre intervention knowledge scores. Doctors/ANNPs outperformed other disciplines in the anatomy and physiology of lactation and nurses and more experience clinicians had better knowledge of breast milk expression. The intervention was shown to benefit doctors/ANNPs and those who had spent less time working on NICU.

Those who did not benefit as much from the training were the nursery nurses. Nursery nurses total confidence and total knowledge scores increased the least out of all the job role groups and they had lower baseline confidence in knowledge and confidence in practice scores than neonatal nurses. When interviewed, nursery nurses felt that whilst they were seen as experts, providing a good deal of the breastfeeding support on NICU, they did not necessarily feel that they were specialists in terms of their knowledge. This finding may suggest that nursery nurses would benefit from further breastfeeding training support.

It is known that a lack of nursing knowledge in breastfeeding leads to the provision of inconsistent information to mothers in the NICU context (Alves et al. 2013). Further to this the lack of paediatric physician knowledge about breastfeeding is associated with decreased initiation and continuation of breastfeeding by mothers (Holmes et al. 2012). It was therefore important that the eLearning module improved the knowledge and confidence of the multidisciplinary team. All participants interviewed agreed that the eLearning module provided a good level of breastfeeding training for the multidisciplinary team and that it was important that all clinicians shared the same evidence based knowledge. Despite the doctor/ANNP group having higher knowledge scores than other groups both at baseline and following the intervention, their confidence to provide breastfeeding support pre intervention was the lowest amongst all the groups. This suggests that doctors/ANNPs benefited from the training and supports the interview findings where doctors described the content of the eLearning module as both useful and relevant to their practice. Key findings are tabled below (Table 41).

Table 41. Key study findings

- The eLearning module resulted in a significant improvement in both clinician knowledge and confidence and retained knowledge and confidence 6-8 weeks following the training
- Doctors/ANNPs had greater knowledge in the anatomy and physiology of lactation
- Doctors/ANNPs had the greatest improvement in knowledge and confidence following the training intervention
- Nurse had greater knowledge in breast milk expression
- Participants who had worked over 5 years on NICU had the highest levels of confidence
- Nursery nurses benefited the least from the training
- Prior breastfeeding training did not affect knowledge and confidence scores
- Participant experience of using eLearning was positive
- Participant involvement in the pilot stages of eLearning development informed the design of the intervention
- User feedback was positive and participants particularly enjoyed the video format used to deliver training content

8.3 Reflection on the use of the Reeves (2006) model of educational research design

This study employed design-based research principles using Reeves (2006) framework to systematically develop a solution to a problem in a particular context. McKenney and Reeves state that 'educational design researchers attempt to solve significant real world problems while at the same time they seek to discover new knowledge that can inform the work of others facing similar problems' (McKenney and Reeves, 2013 pg.3). The lack of clinician knowledge in the anatomy and physiology of lactation and expression, reported in a study

investigating breastfeeding training needs by Wallace et al. (2013), was identified as the educational 'problem' for this study. This is important because breastfeeding confers many important health benefits on preterm and sick babies, as outlined in Chapter Two. Therefore, this research was driven by the importance of supporting mothers in breastfeeding practices in NICU with the ultimate aim of improving breastfeeding rates at discharge.

Through an iterative cycle of development, testing, analysis, evaluation and reflection it was possible to gain a more informed understanding of why the invention did (or did not) work and how it could subsequently be revised and refined. Each cycle of the development process informed the subsequent design of the eLearning. The use of prototyping phases in design-based research is a strategy to ensure reliability of the design before the final study (Kennedy-Clark 2013). It also serves to inform the researcher of the processes and variables that impact on the learning and learning outcomes. In this study, these issues included technical difficulties with accessing training material, a preference for video format for the delivery of educational materials and ensuring assessment questions were aligned to the training content.

Whilst Reeves (2006) stages of education design research were used to structure the study design, the development of the eLearning intervention followed the principles of eLearning design developed by JISC (2009) and Cook et al. (2010). These two frameworks were highly informative and useful and provided a comprehensive structure to the process. In order to ensure that the quality of the eLearning remains consistent it would be necessary to ensure it was regularly reviewed and updated and this could incur time, effort and money. However, once the body of work in designing and developing the module is completed, this would not necessarily be very labour intensive.

Learner satisfaction and engagement with the subject are key aspects to learning (Magnussen 2008) and therefore it was important that feedback from users that aimed to achieve these principles could inform the development of the training. Wong et al. (2010) reviewed 249 articles that evaluated internet-based medical education and found that whilst

a pedagogically sound course can produce positive learning outcomes, successful interventions required additional factors. They report that perceived ease of use and relevance of learning material was found to increase acceptance of eLearning as a method of delivering education. The success of this eLearning intervention in terms of knowledge improvement could arguably be as much a result of involving clinicians at the design stages and ensuring it was user friendly and relevant to current clinical practice, as having a credible and accurate educational content.

Educators are responsible for facilitating both the learning activities of students and for designing the assessments that assess their intended learning outcomes. However, design based research places value on the input of practitioners to inform the development of the intervention, as this enables the researcher to understand how they impact on the user experience (Herrington et al. 2007). This study demonstrated the importance of involving the learner in the design process because participant feedback guided the study design and resulted in the development of a successful eLearning tool. A mixed methods approach was critical to ensure the feasibility and acceptability of the intervention and to identify challenges that needed to be addressed before conducting the final evaluation. This study used an embedded mixed methods design for the intervention development. The strength of this method was that results from the first phase captured the necessary feedback and raised questions that informed the design of the subsequent phase. This approach facilitated changes to the intervention. The NUCAT assessment process provided important information regarding the effectiveness of the training intervention at improving knowledge and confidence but did not necessarily indicate how and why each learner performed as they did. This information was provided through the evaluation process. Qualitative data that explored the user experience provided key information that helped to ensure the eLearning was easy to access, had good usability and provided the necessary information. It also served to ensure that eLearning was a style of education suited to this learner group, although findings from interviews also supported the idea of using the eLearning module as part of a blended learning programme.

Button et al. (2014) reviewed 28 studies relating to issues for students and educators involved with eLearning in pre-registration nursing programs and noted a lack of skills and increased levels of anxiety when using computers. However there was no mention of this in feedback from our study. Button et al., (2014) found the advantages of eLearning included self paced study and flexibility, and whilst nursing students enjoyed many aspects of eLearning many students still wanted face-to-face learning, offered in blended learning. This observation resonates with our study and other findings that web-based activities are supplementary to, rather than a replacement for, face-to-face teaching (Lu Lin and Li 2009; McKinney and Page 2009; Bloomfield and Jones 2013; Koch et al. 2010; Curran Fleet and Kirby 2010). It is important to note that whilst this training was designed as a stand alone educational module it was with the view that clinical support in the NICU context, along with a supervised assessment, would provide a blended approach and this should be considered for future studies.

Education design research is a time consuming and demanding process that required the researcher to lead on a number of aspects of the project that included the development of on line educational materials. Smith et al. (2009) interviewed nurse instructors regarding their experiences of designing eLearning and found that important factors in its success included ensuring that the faculty had sufficient time to develop effective courses. Bailey and Card (2009) interviewed 15 eLearning instructors in South Dakota to discover what enhanced their online teaching and found that of those who are employed in the task of designing such modules are not always effectively trained in these skills and would benefit from more theoretical and pedagogical training. The researcher in this study was not an experienced nurse educator and had no previous experience of developing eLearning. It was therefore necessary to seek advice and support from breastfeeding education specialists and technical experts in the field of eLearning development.

This thesis found that the eLearning module increased self-reported confidence of participants. This supports the findings of a systematic review of nine randomised controlled studies that compared eLearning with conventional learning in nurse education (Du et al. 2013) and found that self-efficacy was improved as a result of eLearning. Undertaking the NUCAT assessment was seen as a useful exercise because it helped participants both identify areas of knowledge weakness and also demonstrate their learning.

However, the aim of the eLearning module created for this study was to support clinicians in practice. Therefore, whilst the learning styles appropriate to its design included associative and constructivist approaches, the ultimate aim was for the learner to use the information in a situative way, by integrating it into their previous understanding and thereby constructing their own meanings when applied to clinical practice. This study provided evidence of learning using Shulman's table of learning (2002), as it demonstrated an improvement in knowledge both immediately post intervention and also the retention of knowledge at 6-8 weeks. However, it did not assess stages 3 to 6 that refer to translating knowledge into action and students' longer and life-long learning. The fourth stage of Shulman's learning is critical reflection and this is seen as a key part of learning because it leads to higher-order thinking (Lai and Sanusi 2013).

For the purpose of supporting reflection this study designed a logbook to accompany the eLearning module. This enabled staff to have access to a text version of the eLearning content and also provide them with an assessment tool and reflective practice diary. However, few participants took the opportunity of downloading this from the website. On reflection the researcher would, in the future, wish to develop a more rigorous method of ensuring learners are engaged in the process of reflection following the eLearning intervention. Future studies that were supported by in-house educational teams would be beneficial in this aim. There were also aspects of the training that were not measured by knowledge outcomes such as 'readiness to learn' theory (Hadsell 2010). Interviews described clinicians' awareness of the delicate nature of approaching mothers to provide breastfeeding

support. They understood that the experience of having a baby on NICU was stressful and that it was important not to place any pressure on the mother with regards to making decisions about how they wish to feed their baby. 'Readiness to learn' theory has the potential to help clinicians' build on their communication skills and future iterations of the assessment could consider including this aspect of learning.

Despite eLearning being a relatively efficient and effective method of educating a large number of learners there is a paucity of studies that have evaluated its educational impact. Dariel and Wharrad (2013) interviewed nurse educators to explore the underlying factors influencing eLearning adoption in nurse education and found that scepticism or indifference towards technology has hindered its wider adoption. This was not as a result of resistance to technology or failure to engage in progress but rather it has been driven by a lack of guidance as to how to develop eLearning. Factors such as a lack of time and training were also cited as barriers to eLearning adoption. As a result they call for eLearning promotion strategies and an educational discourse that reflects the realities of teaching practice in a nurse education context. This study provides a valuable contribution to this field of knowledge and in particular the field of educational design theory that is still an emerging genre of educational enquiry (Anderson and Shattuck 2012; McKenney and Reeves 2013)

None of the studies in the literature review (Chapter Two, Section Three) had used eLearning to deliver the training content. However, a number of studies that have used eLearning to successfully provide clinicians with breastfeeding training, outside of the NICU context, have been published. One very recent one described a large, U.S. study that was undertaken over a 12-year period that evaluated an online educational programme that comprises seven modules that took learners 2-4 hours to complete (DeLoian et al 2015). Originally aimed at medical staff, the authors describe their surprise that the largest group of health care professionals using the program was nurses and nursing students with a total sample size of 7570. Using a pre-test/post-test design, base line knowledge showed a similar deficit in the knowledge area of anatomy and physiology. However, with the lowest median pre-test score

of 60% baseline scores were over all fairly high. This study did not describe the development of the learning material and did not report item analysis to determine reliability of the questionnaire.

Condon et al. (2015) undertook a study that evaluated the responses of 66 health visitor students regarding their satisfaction with an online breastfeeding training package. This was designed to deliver the theoretical aspects of infant feeding in tandem with practical experience and face-to-face teaching. Student attitudes to online learning were predominantly neutral but they had the necessary skills and ability to use the programme. However only 54% stated that they enjoyed learning online whilst only a minority felt the subject was unsuited to online learning. This study assessed student satisfaction with the intervention and did not measure knowledge or report on how long it took to undertake the intervention. In a similar finding to our study, free-text comments included positive feedback about the relevance of the content and easy availability of the information, and negative comments about initial teething problems such as poor sound quality. It is important to note that Condon et al. (2015) recognised that expectations of advanced technology were high, and despite being a pilot study, a less than professional finish was regarded as off putting and impeding training, a design feature that also concurred with the findings in this thesis.

A further online training resource that has proved successful was developed for student health visitors in the UK (Appleton et al. 2014). The aim of this intervention was to build student skills in assessing mother-infant interactions using video footage to illustrate different types of interactions. The project team shared ideas and pilot tested the online materials before running the final evaluation with 46 participants. They report that the training was positively evaluated by 97% of users, though it was noted that there were minor technical issues with sound and installing software to allow videos to play. Amendments to the module focused on signposting within the online site with a plan to distribute the training to a national audience. As experienced in Study One in this thesis, technical issues are common with eLearning and lead to user frustration can ultimately interfere with learning (Moule et al.

2010). This further highlights the necessity to undertake pilot studies during the iterative development of interventions in order to inform design modifications and enhance the chances of a successful intervention.

Bernaix et al. (2008) identified that despite nurses having positive attitudes towards providing lactation support, they felt negative about their ability to impact on the lactation outcomes for mothers, and did not feel supported by their peers and managers. Nurses felt unable to change their behaviours related to breastfeeding best practices until hospital policy and culture changed. This finding is important within the wider context of this study as it indicates that educational interventions alone may not be enough to bring about organisational change. However, the improvement in clinician knowledge through the provision of evidence-based information is a key and fundamental aspect to improving support for mothers on NICU. ELearning offers the benefit of providing consistent information to a work force that struggles with the demands of unsocial hours combined with limited study time. It also contributes to the sustainability agenda by reducing travel. It is the ideal platform to provide didactic information that can be combined with practical clinical support within the NICU environment. As part of a comprehensive training package this eLearning module could reduce the demands of classroom based teaching that breastfeeding support nurses currently provide, therefore allowing them to focus on clinical support and assessment of practical skills.

8.4 Critical evaluation of the contribution of results

8.4.1 Study Strengths

All clinicians working on NICU during the period that the research took place were invited to take part in the study, thereby minimising selection bias. A majority of the workforce within the unit took part in the study; therefore a relatively large sample size was recruited that was

representative of a multidisciplinary workforce from a tertiary NICU. This addresses the limitation that only those who felt comfortable with their knowledge took part. The drop out rates were also extremely low with 89% of those undertaking the baseline NUCAT assessment completing the training and immediate post assessment and 66% of this group completing the NUCAT assessment 6-8 weeks later.

The use of cycles of iteration can build reliability and trustworthiness into a research study by providing checkpoints in the development process that allow the researcher to reflect on results (Kennedy-Clark, 2013). This study undertook two independent pilot phases before the final study and these provided evidence to support the design decisions. Whilst these studies only used small sample sizes Nielsen and Landauer (1993) report the benefits of using small groups in studies for user testing. This is because users generally identify similar aspects of design and therefore the more users that are involved the more information is repeated. They suggest the use of sample sizes as low as five within a series of iterative studies, supporting the validity of the results in the user feedback in this study.

The final iterations (Version Two and Three) of the eLearning evaluated well; participants enjoyed using them and importantly they did not incur technical difficulties thereby ensuring all users had equal access to training materials. Because the training material was not deliverer dependent and could therefore be replicated, this avoids bias whereby the success of the intervention may be dependent on those who delivered it. Content validity is further enhanced due to the high number of users that followed the module instructions signalling that the training materials were easy to use.

One criticism of qualitative research is the lack of generalisability of the results (Sullivan and Sargeant 2011). Whilst the sampling framework was used to capture a range of participants it is possible that experiences reported in the interview study were not reflective of the whole study sample. Also study participants who were interviewed may have been more engaged

with the eLearning design. The use of another method of attaining feedback i.e. survey questions was therefore undertaken in order to gain a fuller range of participants responses.

Dennick et al (2009) state that the most important elements that might be influenced by being online would be content validity and possibly the related concept of construct validity. The NUCAT assessment was further validated as a result of the study. Construct validity was achieved due to the improvement in scores following the intervention. Participants were not exposed to answers of the questions tested and could not therefore discuss the answers amongst themselves. Further to this, the overall pre-test scores were lower than the post-tests scores so therefore real influence of recall is unlikely. Whilst immediate post intervention tests ensured a high response rate from the sample, it was likely that participants would acquire the best scores at this time due to ease of recall. Post intervention assessment was carried out 6-8 weeks after completion of the eLearning module. This provided the study with a longitudinal assessment of the retention of knowledge and confidence. Whether improved knowledge would be maintained over longer period post training is unknown and should therefore undergo further examination. Liu et al. (2001) found that the presentation of more than one medium of information seemed to aid the students' ability to recall information. The use of short videos in the eLearning module (Version 2 and 3) provided audio and written content for the user and user knowledge improved after undertaking these interventions. Liu et al. (2001) also noted that assessment that closely matched the material that was being taught

8.4.2 Study limitations

There are some limitations to the conclusions that can be drawn from this study. Firstly, the study design was not a multisite randomised controlled trial (RCT), which are deemed the "gold standard" within the clinical research paradigm. However, (Sullivan 2011) points out that 'Best Evidence in Medical Education' groups grade the strength of articles on several factors, but not whether the study was randomised. Further to this, single-group pre-test/post-test studies are ubiquitous in medical education (Cook et al. 2007). MRC guidance

places value in non-experimental studies where there is uncertainty regarding the effectiveness of the intervention (Craig et al. 2013) whilst Cook and Beckman (2010) note that pre-tests are better suited to non-randomised designs as is used in this study. In studies without a control group the only way to address confounding is to identify and control the potential confounding variables. In order to establish that the observed outcomes were as a result of the intervention, this section will discuss how potential influence of other factors were minimised in this study.

Cook and Beckman (2010) highlight the fact that pre-tests can be seen as threats to the study design because they familiarise participants with post-test questions, stimulate learning and study following the test and heighten awareness of the requirement to study. They argue that in a truly randomised design the baseline knowledge and skills would be equalised and therefore the pre-test would be unnecessary. However, in this study the pre-test was an integral part of the intervention and correct answers to the questions were not fed back with score results, this served to prevent contamination of answers between participants and also ensured that the repeat test measured knowledge rather than recall of the correct answer. It was also an important part of the study design that participants were aware of their scores in order that this could act as a motivator for learning and could be used to determine whether the participant's confidence in their knowledge was in fact well placed. During the study period there were no other policy or practice changes that could have influenced the participants' knowledge thereby further limiting any factors that may improve knowledge outcome scores.

In order to strengthen study design, paired analysis of pre-test/post-tests scores can be used to control for differing baselines in subjects. In order to avoid error this is further strengthened if the test reliability coefficient is high. One way of measuring this is by item quality, as poor items tend to reduce reliability while good items tend to increase reliability. Item discrimination can be used to ascertain if learners with different degrees of knowledge perform differently on the assessment. An item is considered to be discriminating if the more

knowledgeable learners tend to answer the item correctly while the less knowledgeable learners tend to respond incorrectly (Cohen et al. 2011). In the case of the NUCAT assessment those that could be considered trained to a higher level scored better in the more difficult subject area of anatomy and physiology of lactation, thereby strengthening the test's item discrimination and ensuring test reliability.

External validity refers to the degree to which the results of an empirical investigation can be generalised to and across individuals, settings, and times. Threats to external validity compromise confidence in stating whether the study's results are applicable to other groups (Cohen et al. 2013). This study was conducted in one hospital; therefore it could be argued that findings may not be generalisable across other settings. However, the NICU at UHCW is broadly representative of other tertiary NICUs that are a similar size and have similar level of complexity. UHCW has relatively low breastfeeding rates at discharge, compared to National Data (NNAP 2013), and it was therefore identified as an important location in which to undertake this study.

Threats to internal validity compromise confidence in reporting that a relationship exists between the independent and dependent variables. Threats to internal validity in this study could include rushing the training and performing an Internet search for the answer. Using the same questions and answers in the pre-test and post-tests can also cause improvement through familiarity and therefore fail to assess knowledge. In an attempt to minimise this effect, users were only provided with a post-test score and were not informed of the correct answer. However this could also be seen as a limitation in terms of learning. The assessment was relatively short (20 questions) and would likely have better reliability and validity if more questions were added. However, this would also increase the time participants would have to take to complete the assessment and as they were taking part in the research during their clinical working hours or at home so this may have been an inhibiting factor. The administration of the NUCAT assessment was not proctored and therefore it was not possible to detect if participants looked up the answer whilst doing the test. However, there was no

advantage to doing this as their personal score was for their information only and it was made clear to the participant that they would be given a certificate for taking part in the exercise regardless of number of questions they scored correctly.

A formal sample size calculation was not undertaken, due to the exploratory nature of the study. However, strenuous efforts were made to recruit the largest possible sample to ensure that the sample was representative of the population (Cohen et al. 2013) and the majority of the workforce undertook the NUCAT assessment and training. Further to this the drop out rate over the repeated tests was low. Because there was no pre-specified sample size estimate there could be a degree of uncertainty in the interpretation of statistically significant findings. However, the sample size was fairly large for a study of this kind and this serves as an important step for determining sample size estimates for future work (Lancaster et al. 2004).

The eLearning module was shown to result in a statistically significant improvement in the breastfeeding knowledge and confidence of the participants undertaking the study. However, clinical significance cannot necessarily be inferred from statistical significance and vice versa (Sedgwick 2014). Whilst change in clinical practice was not measured in this study the literature supports the transfer of knowledge into clinical practice. In order for staff to facilitate maternal self-efficacy they must have confidence in their own specialised knowledge and ability to convey correct information to mothers. (Siddell et al. 2003) and Bernaix et al. (2010) measured the influence of personal characteristics and other factors on maternity nurses' ability to provide effective breastfeeding support to mothers and found that knowledge and intentions were associated with nurses' ability to promote breastfeeding. Bernaix et al. (2010) concluded that since knowledge is predictive of supportive behaviour, nurses' knowledge must be accurate and complete to effectively assist breastfeeding mothers. This finding was further supported by (Kronborg et al. 2008) who found that the health visitors' breastfeeding knowledge, but not their positive intention, was associated with their actual supportive behaviour as perceived by the mothers. These findings indicate that

clinically relevant knowledge is important in influencing supportive breastfeeding behaviour among health professionals and supports the need for accurate assessment of educational interventions such as used in this study in order to verify levels of clinician knowledge in this subject.

Whilst the transfer of knowledge and skills to clinical care is an important aspect of establishing the utility of the educational intervention the impact of the eLearning module on clinical outcomes such as breastfeeding duration, breastfeeding initiation and the rate of breastfeeding were not explored in this study. In order to measure effectiveness, outcomes must align with interventions, and therefore in this study it was important to demonstrate the effects on knowledge and confidence before evaluating effects on higher-order outcomes. Previous breastfeeding educational intervention studies have reported a significant increase in breastfeeding rates following educational interventions (Siddell et al. 2003, Pineda et al. 2009) and increased confidence of health care staff following training interventions has also been associated with an improvement in breastfeeding outcomes (Ingram et al. 2011).

Future studies using the eLearning module and NUCAT assessment tool should consider measuring breastfeeding outcomes. However, an isolated eLearning module may not generate the necessary cultural change that is required in a quality improvement programme that aims to improve breastfeeding outcomes. In a systematic review of education and evidence-based practice interventions with health professionals on duration of breastfeeding, Spiby et al. (2009) identify nine studies that report inconsistent breastfeeding outcomes following training interventions. Further to this, they note that guidelines do not usually effect a change in practice unless they are supported by other strategies, such as interactive educational programmes, thereby reflecting the importance of addressing both culture and practice. Implementation science suggests that a multi-method strategy may achieve greater implementation success, and this may be further enhanced when tailored to barriers identified a priori (Scott et al. 2011). Because successful implementation of change in clinical practice is both complex and multifactorial it is subject to barriers such as organisational

factors and attitudes and beliefs of peers (Mahl et al. 2015). In order to understand the dynamics of implementing and integrating a complex intervention, Normalisation Process Theory (NPT) can be used to investigate and address major barriers that impede their effective implementation and determine a causal relationship between the intervention and its impact (McEvoy et al. 2014). As such it can help researchers and clinicians understand and evaluate the factors that inhibit and promote the routine incorporation of health care innovations into practice and could be used in future studies to help guide this process (Nilsen 2015).

The success of a quality improvement programme requires local expertise and engagement from the team of clinicians involved in the improvement initiative (Marcellus et al. 2012). This study relied on the motivation of staff to be willing to take part in a voluntary, educational exercise. One of the main limitations of this study was that the breastfeeding educational team at UHCW were not involved in the process of implementing the eLearning. This resulted in participants having to undertake the NUCAT assessment and training (which took on average around 45 minutes) either whilst at work or in their own time, raising concerns about their levels of concentration and attention. Participant knowledge scores may have been improved if they had been given protected time in which to undertake the training. Future studies should aim to recruit participants during the CPD time allocated for breastfeeding education, thus ensuring they are given adequate time to undertake the training and avoid them having to complete it during normal clinical working hours or in their own time. This could potentially improve their ability to concentrate on the teaching and thereby enhance their learning experience and knowledge scores.

Further to this the use of the logbook that was designed to support clinicians in their clinical practice was not formally evaluated, although user feedback suggested that this was under-used. One explanation for this was the lack of support from the breastfeeding educational team. The logbook was designed to provide both information in written format and also provide space for personal reflection and assessment in practice. Future studies should aim to

engage the breastfeeding educational team, as this would enable this resource to be used in clinical practice to enable the participant to be assessed whilst supporting breastfeeding or breast milk expression. This assessment could then be used to evaluate the impact of the training intervention on clinical practice and be incorporated into outcome measures for future studies.

The study by Wallace et al (2013) provided an insight into the training deficits of this workforce that was used to inform the development of the training material in this thesis. However, it did not explore participants' opinions of the format in which they would like information to be presented. In this thesis eLearning was selected to deliver the educational material based on literature that has reported success using this method within the maternal/neonatal setting (O'Connor et al. 2011; Thukral et al. 2012; Weddig 2011; Velillas et al. 2007; Deloian et al. 2015; Condon et al. 2015). Data were integrated during the evaluation stages of the study, drawing on quantitative and qualitative findings in order to understand which aspects of the eLearning intervention were successful and identify those that required modification. However, further insights could have been achieved if the study had incorporated qualitative interviews prior to commencing the eLearning design. Such an approach may have afforded a greater insight into the training needs and styles of the learners. However, those participants who were interviewed during the development phase provided insightful feedback regarding aspects of the eLearning intervention that was used to guide improvements.

The initial sampling framework used in this thesis was designed to capture a range of participant variables. However, interviews of participants during the development of the training did not include nursery nurses and it was this group of health professionals who were shown to benefit the least from the eLearning in terms of both knowledge and confidence. This may suggest that nursery nurses do not find eLearning a suitable form of training or that they require further education and support. The lack of involvement of nursery nurses during the development phase of the training material could be seen as a limitation of this study.

Interviews with nursery nurses following the intervention indicated that they found eLearning engaging and they were positive about using it, however they also highlighted how clinical experience was integral to breastfeeding training. This further reinforces the recommendation that the use of the logbook in conjunction with involvement from the breastfeeding education team could support a blended learning approach whereby breastfeeding educators in clinical practice would further support the eLearning module content.

The thematic analysis was coded by one researcher and therefore did not undergo inter-rater reliability. Design based research requires the investigator to take on a number of roles that may be conflicting; that of the designer and developer, the facilitator and the evaluator of research (Kennedy-Clark 2013). However, a greater breadth of understanding can be brought into the research environment when multidisciplinary research teams are involved in the design and evaluation process (Craig et al. 2013). In order to ensure that objectivity was maintained, frequent meetings were undertaken with the supervisory team that included subject experts, to evaluate content material and data collection instruments.

The researcher was a senior member of the multidisciplinary team at UHCW, therefore a lack of critical distance may have affected participants' responses during the evaluation, as they may have been hesitant to fully criticise it. Steps were taken to guard against bias regarding the usability of NUCAT. Data was collected anonymously via the NUCAT website and careful attention was paid to feedback from participants. Triangulation in the methods of gathering data through interview, field notes and survey questions helped to ensure that participant views were unbiased. Importantly, not all of the user feedback of the eLearning module or the NUCAT assessment tool was positive.

Lastly, whilst all efforts were made to ensure the eLearning was as comprehensive as possible certain design features that are known to improve eLearning interventions, such as interactivity, could not be incorporated due to the nature of the context of the study or due to time or financial limitations. Participant feedback identified the lack of ability to ask

questions as a disadvantage of the eLearning format and this would further support future research projects that incorporated face-to-face teaching alongside the eLearning module in order to support and supervise clinical practice.

8.5 Recommendations for Future Studies

Based on the findings from this PhD, the following recommendations are made for future NICU breastfeeding research:

- Future studies using the eLearning module and NUCAT assessment tool should not be limited to one location; replication of this study in other settings will provide data to determine the knowledge and confidence outcomes of this eLearning module on other neonatal clinicians.
- Further development of the eLearning module could potentially increase its success as an educational intervention. In this study participants fared better in the subject area of breast milk expression than in the anatomy and physiology of lactation and therefore further improvements could be made to the training material providing information in this subject area. Feedback from the study provided further suggestions for improvement that included more written text during the video, recapping the information at the end of each module and including mini tests within the eLearning module itself. One participant suggested using more 'real' video footage of a mother using a breast pump. Participants felt that the eLearning module should be made freely available in order that staff could access training at any time, including from home.
- The original NUCAT assessment tool included questions relating to other areas of clinical practice in NICU, these included positioning and attachment, the benefits of breastfeeding, kangaroo care and positive touch. Future studies could focus on

developing eLearning to provide educational material that could be assessed using the tool. Clinicians could then have the option of logging into NUCAT and selecting areas of training that they felt most suited to their learning needs following completion of the full assessment.

- Whilst this study found improvement in knowledge and confidence following an eLearning intervention it also included educational material that taught clinicians how to approach mothers to provide them with support. Staff behavioural skills training could be explored further in subsequent training modules and could involve brief behaviour change skills training such as motivational interviewing techniques (Lundahl et al. 2010)
- Replication of this study should be supported by the on site breastfeeding education lead. This would then allow for clinical support in real time practice to enhance the benefits of the theoretical knowledge provided by the eLearning. Further to this, practical assessments of clinicians providing support to mothers should be undertaken to assess the impact of the training on clinical skills and highlight further training needs. The evaluation of whether or not the eLearning made a difference in the clinician's ability to provide breastfeeding support in the NICU setting will provide relevance to the importance of breastfeeding education and its impact on breastfeeding outcomes. The use of the logbook developed to support clinicians in practice should be further explored due its poor uptake in this study.
- Future studies should focus attention on the educational needs of nursery nurses as they are key providers of breastfeeding support and were identified in this thesis as benefitting the least from the eLearning module.
- Further research is needed to determine if the eLearning module improves breastfeeding outcomes on discharge from NICU.

8.6 Conclusion

To date, there are no studies that have investigated the impact of eLearning on health care professionals' knowledge and confidence to support mothers to breastfeed in the NICU. The unique contribution of this study was to develop an eLearning for neonatal clinicians to enhance their knowledge and confidence in supporting mothers with breastfeeding. This study is distinctive in its approach because it develops an eLearning training intervention within an online assessment (NUCAT) to test neonatal clinicians' breastfeeding knowledge and measure their confidence.

Contribution

In a review of methodological challenges to performing systematic reviews of educational interventions for health care professionals, (Gerdprasert et al. 2010) note that many educational studies do not report on needs assessment, curriculum development, learning objectives, instructional strategies, evaluation methods or challenges encountered during implementation of the interventions. This thesis reported on all of these. Further to this, Cook (2012) highlights the need for theory-guided and theory-building studies with robust evaluations that provide practical guidance for subsequent implementations in order to answer the question of how and why educational interventions work. This thesis satisfies these requirements and can therefore inform the process that can translate research about learning, teaching and education, studied in a local context, into generalisable findings (Ringsted et al. 2011).

The study design used in this thesis is supported by the literature that recommends authors produce detailed descriptions of the intervention and context as well as quantitative data on satisfaction and impact of eLearning modules (Wong et al. 2010). In this thesis mixed methods analysis facilitated the exploration of the participants' experience of using eLearning and measured the impact of the training intervention, thereby providing an original and

comprehensive account of research in this field. The strategy used to develop the eLearning intervention was informed by educational design research theory (Reeves 2003). The aim of using education design principles was to produce an eLearning module that had a solid foundation in theory and practice and that had been evaluated by learners who played a significant role in successively improving iterations of its development. Through the use of these design principles the results of this study can be extended beyond the local context to educators in the broader field, thereby increasing impact and transfer of education research into practice. Publications of these methods will provide useful, practical guide for future researchers, educators and clinicians who may be novices in this field and would like to create eLearning resources.

A recent literature review of eLearning in nurse education described an urgent need to develop robust instruments to measure the impact, effectiveness and perceptions of students and educators who are using eLearning (Button et al. 2014). This thesis contributes to the literature concerning the development of instruments to measure the effectiveness of an eLearning intervention. The NUCAT assessment tool was used to measure changes in knowledge and confidence pre and post intervention. This assessment process provided important information regarding the effectiveness of the training intervention, whilst undertaking the NUCAT assessment was seen as a useful exercise because it helped participants both identify areas of knowledge weakness and also demonstrate their learning. Throughout the study the NUCAT assessment tool underwent a process of repeated modification in order to ensure it provided a robust measurement of the impact of the eLearning module.

Issues pertaining to enhancing the learning experiences of health professionals are of global relevance and this thesis contributes to the on-going discourse on eLearning education by offering insights into the needs of neonatal clinicians in providing breastfeeding support. To date, there are no studies that have investigated the impact of eLearning on health care professionals' knowledge and confidence to support mothers to breastfeed in the NICU. In

the neonatal field, two studies have reported nursing attitudes towards supporting breastfeeding (Siddell et al. 2003, Bernaix et al. 2008) but neither looked at nursing confidence in knowledge or confidence in practice. This thesis provided a robust assessment of neonatal clinicians' baseline and post intervention knowledge and confidence supporting breastfeeding practices. It therefore provides an important contribution to the limited literature describing both existing knowledge and confidence levels and the impact of a novel training intervention on these outcomes.

This thesis also contributes to the literature supporting multidisciplinary training interventions as it was undertaken in a clinical setting in a busy, tertiary neonatal unit in the West Midlands and provides original data on the breastfeeding knowledge and confidence of the multidisciplinary team working there. Through using a multidisciplinary approach to education it was possible to identify differences in learning needs across the groups engaged in the study. In this thesis the intervention was shown to benefit doctors/ANNPs and those who had spent less time working on NICU. Nursery nurses total confidence and total knowledge scores increased the least out of all the job role groups and they had lower baseline confidence in knowledge and confidence in practice scores than neonatal nurses. This has provided a unique contribution to the field of neonatal breastfeeding training as nursery nurses were recognised as finding the eLearning style less beneficial to their educational needs.

The economic impact of increasing breast milk feeding among vulnerable infants is widely recognised, as breast milk both protects against disease and reduces the severity of some morbidities in NICU (Gartner et al. 2005, Schanler et al. 1999, Nisbet 2008). Rice et al. (2010) found enhanced staff contact for the promotion of breastfeeding for low birth weight infants to be highly cost effective, primarily because of reduced incidence of necrotizing enterocolitis (NEC). Furthermore, they reported that staff training to provide supportive care was cost effective. This thesis has contributed to the education of NICU staff and has demonstrated an improvement in knowledge and confidence that could impact on clinical care and potentially benefit the health economy.

Finally, this thesis provides an original contribution to the field of breastfeeding education research as it developed a unique method for assessing clinician knowledge and confidence, delivering breastfeeding education and assessing its impact on knowledge and confidence to support breastfeeding. The success of the eLearning module and the lessons learned during the iterative design process provide valuable lessons and a firm foundation from which future eLearning modules could be developed. The design principles identified provide a sound platform from which to develop future online, training resources in conjunction with the NUCAT assessment tool and distribute them to a wider audience. Further areas of potential eLearning training using the NUCAT assessment tool could focus on positive touch, kangaroo care, positioning and attachment and the benefits of breastfeeding, thereby developing a comprehensive training package to support the breastfeeding educational needs of neonatal clinicians.

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Table of Appendix

Appendix 1. BFI UNICEF Three Guiding Principles and Ten Steps to Successful Breastfeeding Expanded for Neonatal Wards.....	326
Appendix 2. Search Strategies Used Chapter 2 Section 3 Literature Review of Educational interventions for clinicians to improve breastfeeding outcomes in NICU.....	327
Appendix 3. Participant information sheet NUCAT and eLearning.....	329
Appendix 4. Consent form NUCAT and eLearning.....	332
Appendix 5. Participant information sheet clinician interview.....	333
Appendix 6. Consent form clinician interview.....	336
Appendix 7. Interview Schedule.....	337
Appendix 8. Poster presentation: Coventry University HLS Post Graduate Symposium 2015 awarded 1 st prize.....	339

Appendix 1

BFI UNICEF Three Guiding Principles and Ten Steps to Successful Breastfeeding Expanded for Neonatal Wards

1. The staff attitude toward the mother must focus on the individual mother and her situation. ▪
 2. The facility must provide family-centred care, supported by the environment. ▪
 3. The health care system must ensure continuity of care, that is, continuity of pre-, peri-, and postnatal and post discharge care.
-
1. Have a written breastfeeding policy that is routinely communicated to all health care staff. ▪
 2. Educate and train all staff in the specific knowledge and skills necessary to implement this policy. ▪
 3. Inform all hospitalized pregnant women at risk for preterm delivery or birth of a sick infant about the management of lactation and breastfeeding and benefits of breastfeeding. ▪
 4. Encourage early, continuous, and prolonged mother–infant skin-to-skin contact (kangaroo mother care) without unjustified restrictions. Place babies in skin-to-skin contact with their mothers immediately following birth for at least an hour. Encourage mothers to recognize when their babies are ready to breastfeed and offer help if needed.³ ▪
 5. Show mothers how to initiate and maintain lactation and establish early breastfeeding with infant stability as the only criterion. ▪
 6. Give newborn infants no food or drink other than breast milk, unless medically indicated. ▪
 7. Enable mothers and infants to remain together 24 hours a day. ▪
 8. Encourage demand feeding or, when needed, semi-demand feeding as a transitional strategy for preterm and sick infants. ▪
 9. Use alternatives to bottle-feeding at least until breastfeeding is well established and use pacifiers and nipple shields only for justifiable reasons. ▪
 10. Prepare parents for continued breastfeeding and ensure access to support services/groups after hospital discharge. ▪

Appendix 2

Search Strategies Used in Chapter 2 Section 3: Literature Review of Educational interventions for clinicians to improve breastfeeding outcomes in NICU

Set #	Searched for	Databases	Results	Relevant
S6	(breast milk storage) AND (neonatal intensive care unit OR NICU) AND (staff knowledge OR staff confidence OR self-efficacy) AND (staff education)	British Nursing Index, ProQuest Hospital Collection	327	0
S5	(storing breast milk) AND (neonatal intensive care unit OR NICU) AND (staff knowledge OR staff confidence OR self-efficacy)	British Nursing Index, ProQuest Hospital Collection	79	0
S4	(storing breast milk) AND (neonatal intensive care unit OR NICU) AND (health care provider knowledge OR health care provider confidence)	British Nursing Index, ProQuest Hospital Collection	76	0
S3	breastfeeding AND (neonatal intensive care unit OR NICU) AND (health care provider knowledge OR health care provider confidence)	British Nursing Index, ProQuest Hospital Collection	1131	1
S2	breastfeeding AND (neonatal intensive care unit OR NICU) AND (staff knowledge OR staff confidence OR self-efficacy) AND (education OR intervention)	British Nursing Index, ProQuest Hospital Collection	1158°	2

S1	breastfeeding AND (neonatal intensive care unit OR NICU) AND (staff knowledge)	British Nursing Index, ProQuest Hospital Collection	1107°	7
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Search	Pubmed Query	Items found
#37	Search (((staff OR personnel))) AND ((NICU OR neonatal intensive care unit))) AND ((breast feeding OR breastfeeding))	90
#36	Search ((((((education OR educational OR educate))) AND training) AND ((breast feeding OR breastfeeding))) AND ((staff OR personnel))) AND ((NICU OR neonatal intensive care unit))	30
#27	Search ((((((education OR educational OR educate))) AND training) AND ((breast feeding OR breastfeeding))) AND ((staff OR personnel)))	794
#11	Search ((((((staff OR personnel))) AND ((NICU OR neonatal intensive care unit))) AND ((breast feeding OR breastfeeding))) AND training) AND ((education OR educational OR educate))	30
#10	Search (staff OR personnel)	438691
#9	Search (NICU OR neonatal intensive care unit)	20299
#8	Search (breast feeding OR breastfeeding)	36208
#7	Search training	1086245
#6	Search (education OR educational OR educate)	1052901

Search ID#	CINAHL Search Terms	Results
S14	S3 AND S5 AND S11	10
S13	S3 AND S5 AND S6	3
S12	S3 AND S7 AND S11	9
S11	(MH "Education") OR "education"	355,566
S10	S3 AND S4 AND S7	0
S9	S3 AND S6 AND S7	2
S8	S4 AND S5 AND S6 AND S7	7
S7	"intervention"	98,780
S6	"training"	84,224
S5	"staff"	80,524
S4	(MH "Education")	4,162
S3	S1 AND S2	335
S2	(MH "Intensive Care Units, Neonatal") OR "NICU"	7,399
S1	"breastfeeding" OR (MH "Breast Feeding") OR (MH "Breast Feeding Promotion")	13,523

Appendix 3

Participant Information Sheet NUCAT and eLearning

LONG TITLE **Improving neonatal unit staff knowledge and practices for breastfeeding support and engagement of parents in the care of babies in the neonatal units.**

Extension Project: (Neonatal units - NUCAT and E Portal)

Health care professionals working on the neonatal units of University Hospitals Coventry are being invited to take part in a study that will assess the knowledge and training needs of staff both before and after undertaking an e learning module covering:

- The anatomy and physiology of lactation
- Breast milk expression

Why have I been asked?

You have been invited to participate because you are a health care professional working on the neonatal unit at UHCW.

What am I being asked to do?

You are being invited to take part in an on line assessment and then undertake some eLearning and re testing. You may also be asked to undertake an interview about your experience of the e learning and the application to practices. We will ask you to agree to your name and work email (or another e mail if you choose) to be uploaded into a website and held securely for the duration of the project only. You will initially log onto the E Portal NUCAT website and undertake, anonymously, a short survey (Neonatal Unit Clinician Assessment-NUCAT) including multiple-choice questions testing evidence-based practices. These may include some clinical film clips and photographs to test how you apply knowledge in real clinical practice. There are also some questions used to describe who you are (gender, education, job role, experience and training) so we know the spread of staff who have completed it. We will also ask for your views regarding your confidence to use this knowledge in practice and any suggestions you have to improve practice in the unit. You will be able to view your

percentage correct scores on the knowledge items at the end of each survey. This information will be private to you only. You will then be invited to undertake some e learning on the specific subject area that you have been tested in. Once you have completed this you will be asked to re-take the NUCAT assessment, which will also ask you your views about the e learning. Please allow up to 60 minutes completing the on line survey, e learning and post learning survey in one sitting. We would also like you to repeat the NUCAT assessment after a period of clinical practice of around 6-8 weeks. If you agree to take part, we will send you instructions on how to access the NUCAT on-line survey and E Portal. You will be asked to agree by replying to an e mail or signing a form that you agree to us uploading your name and e mail to the site. You will be asked once you access the site to conform consent to undertake the study.

Do I have to take part?

No. Participation is entirely voluntary. If you change your mind about taking part in the study you can withdraw at any time. If you do decide to withdraw all your data will be destroyed and will not be used in the study. There are no consequences to deciding that you no longer wish to participate in the study.

What are the possible disadvantages and risks of taking part?

We are not aware of any significant risks to you in taking part.

What if something goes wrong?

You can contact a researcher at any time during the project if you are not happy. If you are still not happy, you can contact Professor Ian Marshall (Pro Vice Chancellor-Research) at Coventry University (contacts below).

Will my taking part in this study be kept confidential?

Yes. This study will comply with the Data Protection Act 1998 and your participation will be kept confidential. All the information you provide will be kept confidential unless we believe that you or someone else is at risk of serious harm in which case we would tell you before the information is passed on to somebody who can help. Your name and e mail will be stored in the system only for the purposes of the study and will only be accessible to those managing the research. These personal details will be deleted as soon as your participation in the project is complete. Only members of the research team will have access to the data, which will be kept in a password-protected folder. All electronic information will be archived for 3 years following the completion of the study, after which they will be deleted. Your responses will only be identified by your participant code number in the survey system and e learning module and in downloaded data used to analyse all participants' data.

Benefits of taking part

You will have the benefit of being involved in a process that may lead to a greater understanding and awareness of this important aspect of your care-giving role. It is possible that involvement in the study will enable you to think about your practice and skills. Taking part may also help you to consolidate your learning about providing breastfeeding support to mothers and other practices to support parents in the care of their newborn in the unit, whilst also giving you the opportunity to highlight areas of practice that may require improvement. We hope that your participation in this research will increase your knowledge and practice of supporting parents in their baby's care. Importantly, the results will inform the plans for training and updating policies in the unit.

Who is organising and funding the research?

The research is being conducted and funded by Coventry University

The results of the study

The results of the study will enable us to understand the level of knowledge and skills of clinical staff and their experiences in supporting family care and breastfeeding practices.

Who has reviewed the study?

This project has been reviewed and approved by Coventry University and approved by Trust research governance procedures.

Contact Details

Wendy Higman
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Appendix 4

Consent Form NUCAT and eLearning

LONG TITLE **Improving neonatal unit staff knowledge and practices for breastfeeding support and engagement of parents in the care of babies in the neonatal units.**

Extension Project: **(Neonatal units - NUCAT and E Portal)**

Lead Researcher at Coventry University: Professor Louise Wallace

	Please initial
I confirm that I have read and understand the information sheet for the above research and have had the opportunity to ask questions.	
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.	
I agree for my name and email address to be stored in the on line system only until participation is complete.	
I agree to be contacted about taking part in the survey. My answers will be stored with my personal information removed from all records. My words and other data will not be used to identify me.	
I agree to take part in the above study.	

Name of Participant Date Signature

Name of person taking consent Date Signature

Participant Information Sheet - Interviews

LONG TITLE **Improving neonatal unit staff knowledge and practices for breastfeeding support and engagement of parents in the care of babies in the neonatal units.**

Extension Project: (Neonatal units - NUCAT and E Portal)

You are being invited to take part in a study. Before you decide it is important for you to understand why the study is being done and what it will involve. The researcher will go through this information sheet with you and answer any questions that you have. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Talk to others about the study if you wish.

What is the study about?

Clinicians working in the neonatal unit are being asked to take part in a study about assessing the knowledge and training needs of staff in key skills to support breastfeeding of babies while in the unit.

Why have I been asked?

You have been invited to participate because you are a health care professional working in the neonatal unit.

What am I being asked to do?

You are being invited to take part in an interview, regarding your clinical practices and your views of the knowledge and practices assessed in an on line test the Neonatal Unit Clinician Assessment Tool - NUCAT, and how your training needs might be met.

If you decide to participate, you will be asked to take part in an interview. This will be conducted at work or over the telephone at a time that best suits you. Before you take part, the researcher will make sure you understand the purpose of the study, and will ask you to sign a consent form. The interview will take approximately 20 -30 minutes.

Do I have to take part?

No. Participation is entirely voluntary. If you change your mind about taking part in the study you can withdraw at any time. If you do decide to withdraw all your data will be destroyed and will not be used in the study. There are no consequences to deciding that you no longer wish to participate in the study.

What are the possible disadvantages and risks of taking part?

We are not aware of any significant risks to you in taking part.

What are the possible benefits of taking part?

We are interested in your experience of undertaking the eLearning module and NUCAT assessment in order to ensure that it can best meet the needs of neonatal clinicians to support breastfeeding practices. We are also interested to current practices to support mothers with breast milk feeding in order to further inform educational materials.

What if something goes wrong?

You can contact a researcher at any time during the project if you are not happy. If you are still not happy, you can contact Professor Ian Marshall (Pro Vice Chancellor-Research) at Coventry University (contacts overleaf).

Will my taking part in this study be kept confidential?

Yes. This study will comply with the Data Protection Act 1998 and your participation will be kept confidential. All the information you provide will be kept confidential unless we believe that you or someone else is at risk of serious harm in which case we would tell you before the information is passed on to somebody who can help. The voice recording will be destroyed once it has been transcribed. The transcript will be allocated an identifying number and your name removed from the interview, and those of anyone you mention in the interview by name. Only the researchers involved in the study will be able to link this number with you. There will be no way to identify you in any written report. Electronic data will be stored in password protected files under the security policies of the University. A hard copy of the transcript will be stored in locked filing cabinets in the researchers' office at Coventry University. These will be destroyed 3 years after the end of the study in line with University policies.

What will happen to the results of the research study?

The results will enable us to understand your knowledge and experiences in supporting breastfeeding practices. They will also enable us to identify ways to design effective breastfeeding education in neonatal units. The results may also be presented at academic conferences and/or written up for publication in peer reviewed academic journals.

Who is organising and funding the research?

The research is being conducted and funded by Coventry University

Who has reviewed the study?

This project has been reviewed and approved by Coventry University and approved by Trust research governance procedures.

Contact for further information

If you would like any further information about this research, please get in touch with the researcher at the address below:

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Appendix 6

Consent Form Interview

LONG TITLE **Improving neonatal unit staff knowledge and practices for breastfeeding support and engagement of parents in the care of babies in the neonatal units.**

Extension Project: **(Neonatal units - NUCAT and E Portal)**

Lead Researcher at Coventry University: Professor Louise Wallace

	Please initial here
I confirm that I have read and understand the information sheet for the above research and have had the opportunity to ask questions.	
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason	
I agree that the audio information I provide in the interview can be audio taped, transcribed, stored with my name removed from all records and my words used in the presentation of the research. My words will not be used to identify me.	
I agree to take part in the above study.	

Name of Person Date Signature

Name of Person taking consent Date Signature
(If different from researcher)

Appendix 7

Staff Interview Questions

1.0 ABOUT YOU

- 1.1. What is your professional role in this unit (Job title)
- 1.2. How long have you worked in neonatal units? How long in this unit?
- 1.3. How much of your working week is spent in direct care of babies and parents?

2.0 NUCAT EXPERIENCE

- What did you feel about the knowledge of practices being tested?
- Did you experience any difficulties with any questions? (if so which and why)
- Were there aspects of knowledge and practices tested you think should not be known by all clinical staff (prompts-what/why - give examples)
- What did you think of the training content? (Prompt – was it comprehensive? Did it meet your learning needs?)
- Did you like the design of the training? (Prompt – did you find it easy to understand? Did you like the use of visual audio aids? Was there any other way you would have liked the training to be delivered – PowerPoint slides/teaching sessions?)
- How useful has it been to your clinical skills – have you used the knowledge learnt?
- Do you feel comfortable using e learning?
- Do you think this type of knowledge is suited to e learning?
- Is there anything you want to add about the on line training and assessment?

2.1 How would you like to have feedback about your NUCAT test scores?

2.2 What training do you think you need in practices tested by NUCAT?

2.3 How do you feel it is best to be updated in these practices?

2.4 Is there anything else you would like to add?

3.0 QUESTIONS ABOUT CURRENT PRACTICE AND TRAINING

Have you had any training relevant to supporting parents to be engaged in their babies' care, such as training in breastfeeding support, in the past 2 years- if so what/ when/ how useful was it?

- Was there anything that you felt was missing from the training?

- Has is provided you with the skills you need to support mothers in NICU?

Please explain if you currently support mothers to breastfeed, how you currently

- Support hand expression? (What helps/hinders this?)
- How much do you think it improves outcomes for the baby and the family - please explain any benefits or problems it may cause for them?
- How much do you find mums want you to help them with this practice? (Prompt- do you suggest it or do they?)
- How much do you know about why hand expression is used in neonatal care- what evidence are you aware of, how much do you think this is “evidence based”? Do you think your clinical colleagues share this view - if no - what do they say about this practice?
- How much is hand expression something you feel you have been taught to do (a) is in your job role (b) you are trained to do (c) you are confident to do?
- What is the relationship between the NICU and the PNW with regards to supporting BME and breastfeeding?
 - What could help this relationship? Who should manage maternal support?
- Do you visit mothers on PNW to provide support and updates?

THANK YOU

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